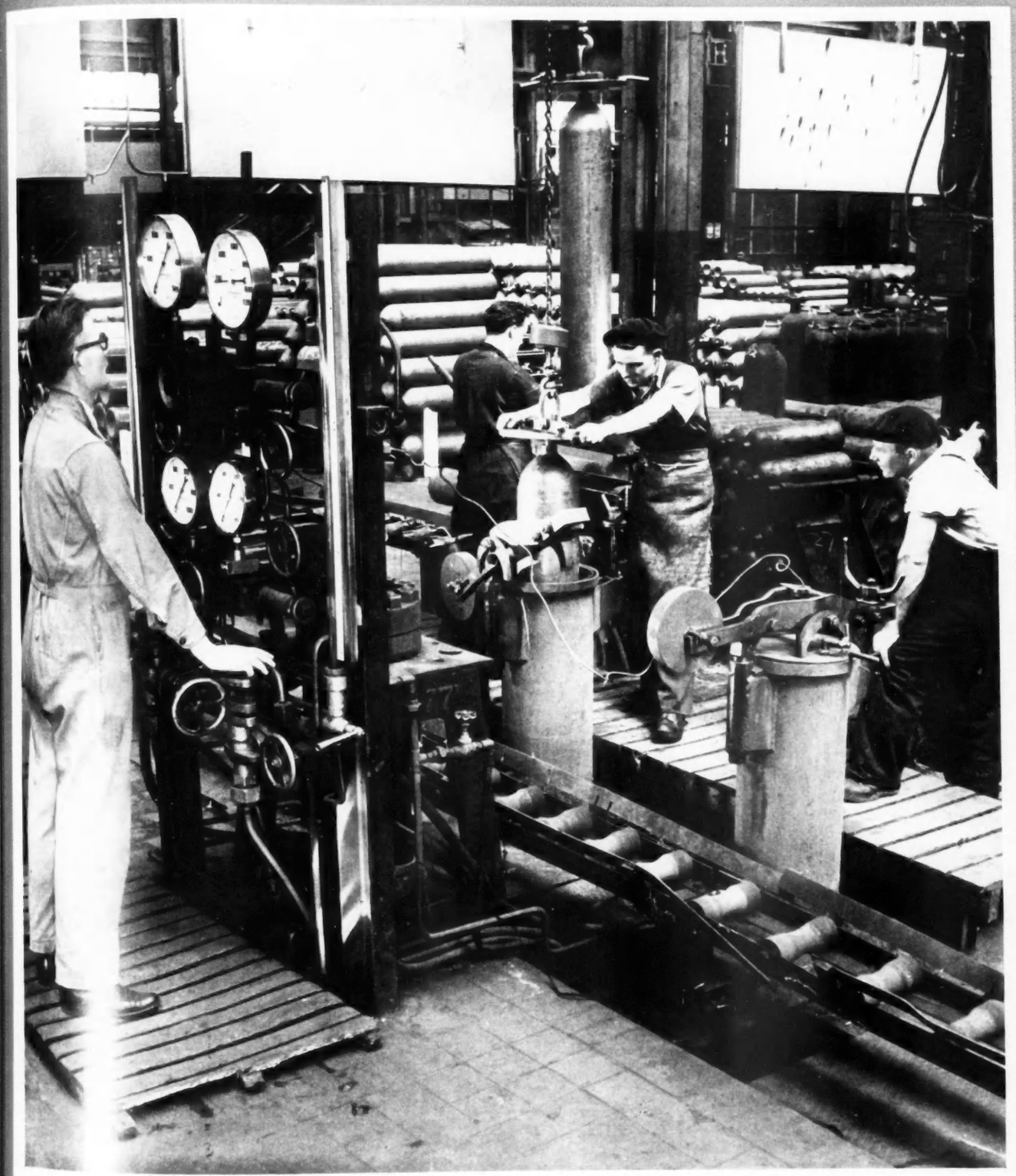
ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 181 No. 4701 *LONDON, FRIDAY, APRIL* 13, 1956 PRICE 2s.



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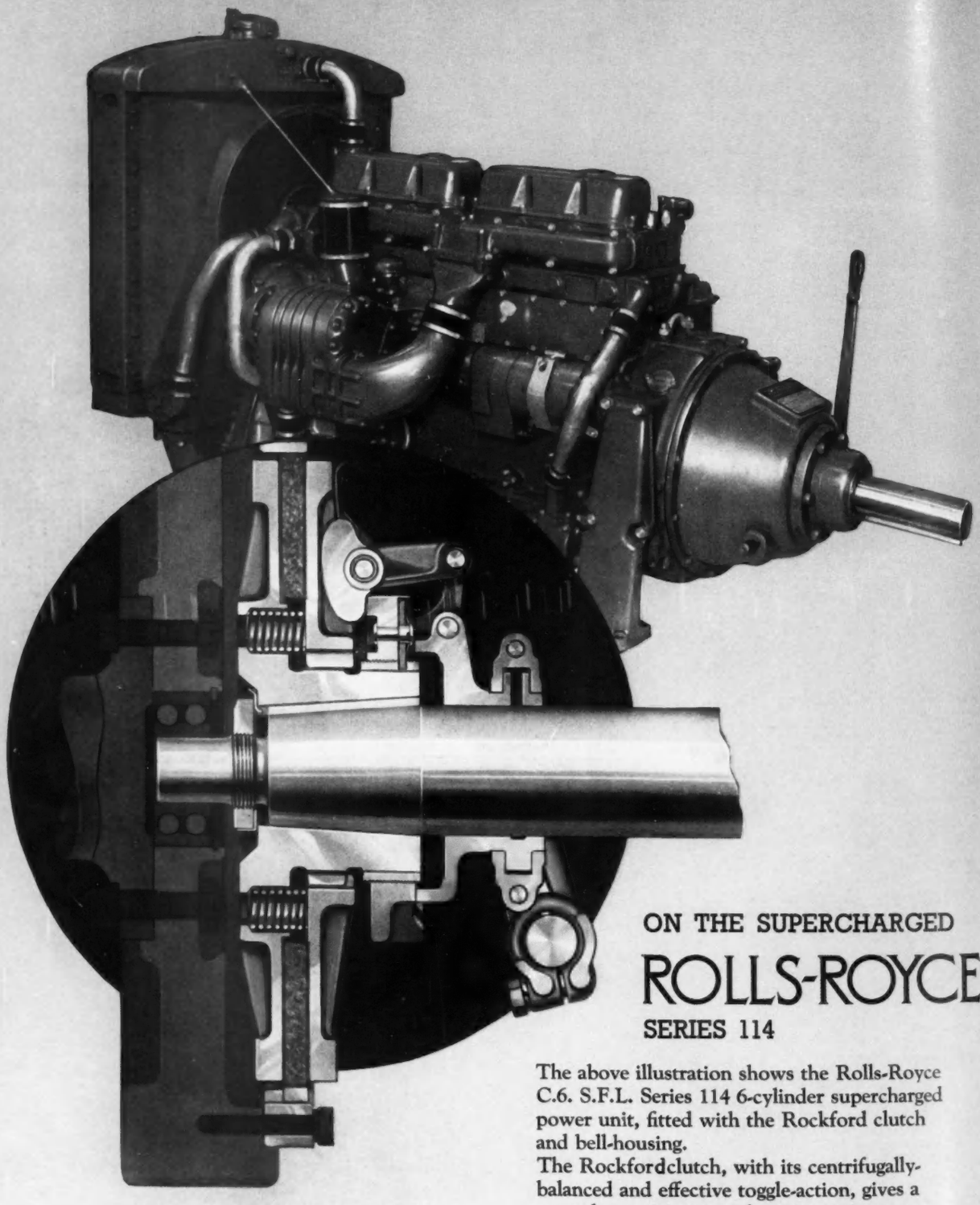

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The above illustration shows the Rolls-Royce C.6. S.F.L. Series 114 6-cylinder supercharged power unit, fitted with the Rockford clutch and bell-housing.
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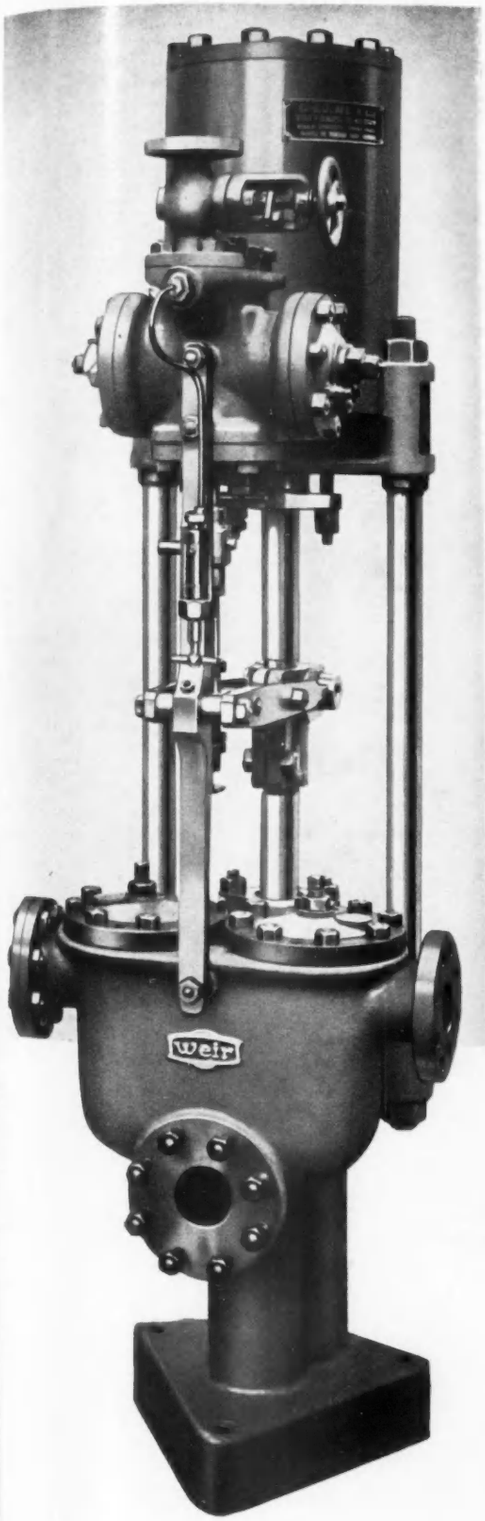

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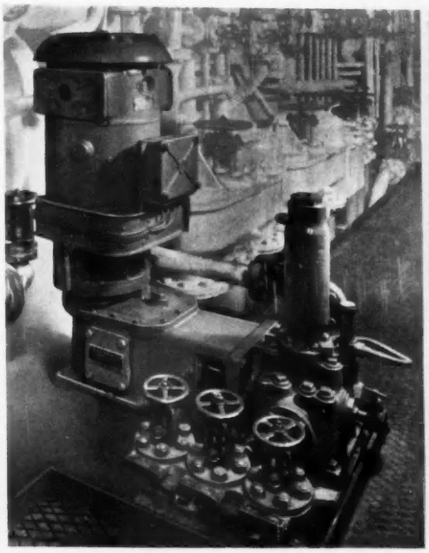
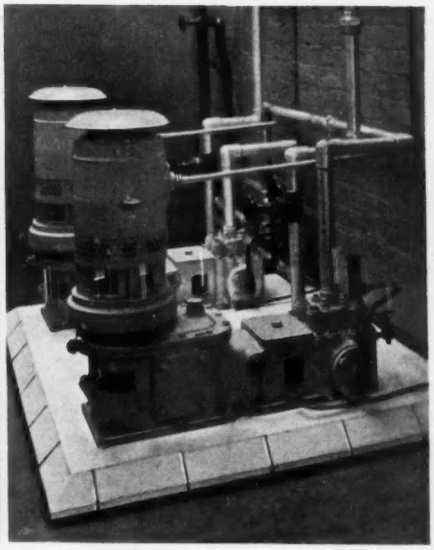
Boiler Feed Pumps





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provide economic and efficient boiler feeding from 130 to 1100 gallons an hour at discharge pressures up to 250 lb./sq. in. Pump automatically controlled to meet boiler requirements. Write for illustrated leaflet No. GB.121.

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CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2. Inclusion of advertisements must be dependent on space being available.

EDUCATIONAL.

FREE. Brochure giving details of courses in **Mechanical** and Production Engineering, Draughtsmanship, etc., for the **A.M.I.Mech.E., A.M.I.P.E., City and Guilds** and other Professional examinations. **B.M.I. INSTITUTES**, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.). G 619

PUBLIC NOTICES.

ROYAL CORPS OF NAVAL CONSTRUCTORS

SCHOOLS ENTRY.

A COMPETITION for a new form of entry into the Royal Corps of Naval Constructors will be held in July, 1956.

Accepted candidates will be established as Probationers in the R.C.N.C. and will undergo a 2-year course of training at the R.N. Engineering College, Manadon, and in H.M. Dockyard, Devonport, followed by a 3-year course at the R.N. College, Greenwich.

Candidates must be aged between 18 years and 19 years 6 months inclusive on 1st September, 1956.

Candidates with the General Certificate of Education will be required to have passed at Advanced Level in at least Pure Mathematics, Applied Mathematics and Physics, and to produce evidence of general education at Ordinary level.

Candidates with the Scottish Leaving Certificate will be required to have higher grade passes in Physics and Mathematics and at least lower grade passes in English and a language other than English and two other subjects (preferably mathematical).

Candidates from schools in Northern Ireland will be required to produce a certificate from the Ministry of Education in Northern Ireland showing a comparable standard to that above.

The work of the R.C.N.C. covers all aspects o design construction and repair of H.M. Ships. Members undertake to serve wherever required at Admiralty Headquarters and outports in the United Kingdom, and at Royal Dockyards at Home and Abroad. The Head of the R.C.N.C. is the Principal Technical Adviser to the Board of Admiralty.

Total pay for probationers will commence at £313 10s. 0d. p.a. at the R.N.E.C. at age 18, rising to £575 at Greenwich at age 23. The successful probationer can expect appointment as Assistant Constructor usually at age 23 with total pay (London) of £805. Promotion to constructor is at about age 30 with total pay of £1399 rising in 9 years to £1750. Promotion to higher ranks with top salary £3500 is by selection.

Full particulars may be obtained from the SECRETARY OF THE ADMIRALTY, C.E. BRANCH II, EMPIRE HOTEL, BATH, to whom final applications must be submitted by 15th June, 1956. K 999

THE COLLEGE OF AERONAUTICS.

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS.

Applications are invited for a

RESEARCH FELLOWSHIP which has been established at the College by the English Electric Co., Ltd. The Fellowship is intended to provide opportunity for post-graduate research into problems of vibration or stability and control of aircraft, and is tenable for one year beginning on or about 1st October, 1956. The value of the Fellowship is £500.

Applications, giving full particulars of education and experience and quoting the names of three referees, are required by 1st May, 1956, and should be addressed to: THE WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. K 909

COUNTY OF LONDON.

BUILDING BY-LAWS.

LONDON BUILDING ACTS, 1930-1939.

The London County Council gives notice, in accordance with Section 8 (*a*) of the London Building Act (Amendment) Act, 1935, that it proposes, not less than two months from the date of this notice, to make by-laws being an amendment of the London Building (Constructional) By-Laws, 1952, made under the above-mentioned Acts with respect to

(i) **THE EXTERNAL AND INTERNAL CLADDING OF BUILDINGS,** being an addition to Part III (Materials of Construction) of the said By-laws;

(ii) **THE PROTECTION OF STRUCTURAL STEELWORK,** being the substitution of a by-law for By-law 6.02 of Part VI (The Structural Use of Steel) of the said By-laws, and

(iii) Matters incidental thereto.

Any authority, body or person desirous of objecting to any proposed by-law may do so within six weeks after the publication of this notice by a letter addressed to the MINISTER OF HOUSING AND LOCAL GOVERNMENT, WHITEHALL, LONDON, S.W.1, setting out the grounds on which objection is made.

Copies of the proposed by-laws are deposited at the County Hall (Room 311A), Westminster Bridge, S.E.1, and are open to public inspection without payment on any week-day during the usual office hours.

Copies may be obtained from the Clerk of the Council (T/BL) by sending a stamped addressed envelope.

W. O. HART,
CLERK OF THE LONDON COUNTY COUNCIL.
THE COUNTY HALL, S.E.1.
28th March, 1956. (634) K 978

CENTRAL ELECTRICITY AUTHORITY.

Pursuant to the provisions of Section 37 (1) of the Electricity Act, 1947, the following Tariff for the supply of electricity by the Central Authority to the Area Boards has been fixed for the year ending 31st March, 1957.

TARIFF.

Electricity will be supplied at this Tariff during the year of account to the Area Board at the points of supply at which electricity was being supplied to the Board by the Central Authority at the commencement of the year of account or at such points as may be agreed between the Central Authority and the Area Board.

The price to be paid for electricity so supplied in the year of account shall be the sum of the charges set out in paragraphs (A) and (B) hereunder :—

(A) FIXED KILOWATT CHARGE

For each kilowatt of simultaneous maximum demand on the Central Authority the sum of £5 0 0 (five pounds).

For the purpose of ascertaining the amount of the fixed kilowatt charge twice the largest number of kilowatt-hours supplied by the Central Authority to the Area Board during any half-hour between 7.0 a.m. and 7.0 p.m. on any Monday, Tuesday, Wednesday, Thursday or Friday, or between 7.0 a.m. and 12.0 noon on any Saturday in the year of account shall be the maximum demand and the " simultaneous maximum demand on the Central Authority " shall be the said maximum demand PROVIDED that if the sum of the said maximum demands of all the Area Boards and the chargeable maximum demands in the year of account of other direct consumers of the Central Authority in England and Wales varies by more than one per cent. from 18,000,000 kilowatts the " simultaneous maximum demand on the Central Authority " shall be the said maximum demand multiplied by 18,000,000 and divided by the sum of the said maximum demands of all the Area Boards and the said chargeable maximum demands of other direct consumers.

(B) RUNNING CHARGE

For each kilowatt-hour supplied by the Central Authority to the Area Board during the year of account the sum of 0.5d. (decimal five of a penny).

VARIATION OF THE RUNNING CHARGE

The running charge shall be increased or reduced by 0.0006d. (decimal nought nought nought six of a penny) for each penny (a halfpenny or any greater part of a penny being treated as a penny) by which the fuel cost per ton in the year of account shall be above or below 60/- (sixty shillings).

For the purpose of this variation:—

(*a*) **FUEL COST PER TON** in any period shall be determined as follows:

The total cost of fuel consumed in the period at all the Central Authority's stations in the area of the Area Board taking the supply shall be divided by the total number of tons of fuel so consumed and the cost per ton so obtained shall be multiplied by 11,000 and divided by the average gross thermal value of the fuel so consumed expressed in British Thermal Units per lb.

(*b*) **" COST OF FUEL CONSUMED "** shall mean the sums expended for fuel consumed plus the cost of any transport, handling, preparation or treatment incurred in connection with the delivery of the fuel to boiler hoppers or furnaces and in connection with the disposal of the products or residues of combustion, together with the proper proportion of salaries and wages, and any contributions for pensions, superannuation and insurance of officers and servants attributable thereto, less any sums received from the sale of any products or residues of combustion.

ERNEST LONG,
Secretary.

March 1956
CENTRAL ELECTRICITY AUTHORITY,
CENTRAL ELECTRICITY HOUSE,
TRAFALGAR BUILDINGS,
1 CHARING CROSS,
LONDON, S.W.1.
TB/8943 L 6

A CAREER AS A REGULAR ARMY OFFICER FOR QUALIFIED ENGINEERS.

MECHANICAL, ELECTRICAL AND ELECTRONIC ENGINEERS are required as officers in the Corps of Electrical and Mechanical Engineers.

THERE ARE TWO METHODS OF ENTRY. These are either :—

(i) On a short service commission (which offers a good opportunity of obtaining a permanent commission) with a gratuity of about £100 for each completed year of service on leaving, or

(ii) On a Permanent Regular Commission with a valuable pension and a terminal grant of between £1500 and £3450 (tax free).

Candidates must be physically fit and between the ages of 23 and 28 years old (except for those with previous service in the Armed Forces, who may be 30 years old). They must have passed or be exempt from the examinations for Graduates of either the Institution of Mechanical Engineers or the Institution of Electrical Engineers or have a University Degree in Natural Science or Engineering. In addition, 2½ years experience as an Engineer (or 1½ years in the case of University graduates) is normally required. Additional seniority is given for an honours degree and for approved engineering experience.

The pay which R.E.M.E. officers may expect is according to the following table:—

RANK	NORMAL AGE	IF SINGLE	IF MARRIED
Lieutenant ...	23	808	—
Lieutenant ...	25	881	972
Captain ...	27	1027	1125
Major	34	1392	1486
Lt.-Colonel ...	42	1809	1887
Colonel	45	2168	2242
Brigadier ...	49	2587	2644
Major-General ...	49 or over	3373	3438

NOTE.—This is the U.K. scale; there are various additions in certain overseas stations.

(In this table the figure of a single officer's pay include an element for food and accommodation which are normally in kind. This has been made to provide a direct means of comparison with civilian scales of pay.)

For further details please write to :—
THE WAR OFFICE (AG21), STANMORE, MIDDLESEX, and quote this announcement. K 979

LECTURES.

THE COLLEGE OF AERONAUTICS.

A Course of Lectures on
AERODYNAMIC PRINCIPLES OF THE HELICOPTER,
will be given at the College from Monday, 28th May, to Friday, 1st June, 1956.

The course will deal with the basic aerodynamics and performance of rotating wing aircraft, including discussions on problems of stability and control.

FEES for the course are:
Tuition Fee ... ... £15 15s. 0d.
Residence Charge ... ... £6 10s. 0d.
(including full board)

A copy of the syllabus and Forms of Enrolment can be obtained from THE WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. L 21

EXPERIMENTAL WORK.

RESEARCH ENGINEERS LIMITED,

Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required. G 656

TENDERS.

Sealed **TENDERS** are invited for the **MANUFACTURE, SUPPLY AND ERECTION (WHERE NECESSARY), AT NEYVELI, SOUTH INDIA, OF OPEN CAST MINING EQUIPMENT.** Full details can be obtained from THE CHIEF ACCOUNTANT, GENERAL SUPERINTENDENT'S OFFICE, LIGNITE INVESTIGATIONS, NEYVELI, NEYVELI POST OFFICE, SOUTH ARCOT DISTRICT, SOUTH INDIA, on payment of Rs. 25.6as.3p. per set. This amount will not be refunded on any account.

The last date for receipt of tenders in respect of equipment included in Schedule " X " is May 2, 1956, and that for equipment included in Schedule " Y " June 4, 1956.

Tenders must reach the office at Neyvell before 10 a.m. on the closing dates. K 989

CONSULTANTS

TEAM OF DESIGNERS available for **Mechanical** and Production Engineering **Special Machines** and Projects. **NORRIS BROTHERS**, LTD., 53, Victoria Street, London, S.W.1. Tel.: Abbey 5444. G 530

PUBLIC APPOINTMENTS.

THE ROYAL TECHNICAL COLLEGE, GLASGOW.
(Affiliated to the University of Glasgow.)

DEPARTMENT OF MECHANICAL, CIVIL, AND CHEMICAL ENGINEERING.

CHAIR OF CIVIL ENGINEERING.

The Governors of the Royal Technical College, invite applications for the Chair of Civil Engineering tenable in the Department of Mechanical, Civil, and Chemical Engineering. The salary attached to the Chair is £1900 by £100 to £2200. Particulars of the appointment and forms of application may be obtained from the SECRETARY-TREASURER, GEORGE STREET, GLASGOW, C.1. K 897

ADMIRALTY.

ROYAL NAVAL SCIENTIFIC SERVICE require **SENIOR SCIENTIFIC OFFICERS** and **SCIENTIFIC OFFICERS** in Experimental Establishments chiefly in Weymouth, Cheltenham and Portsmouth areas and Home Counties. Majority of posts for Electronic Engineers, Physicists (particularly with Electronics), and Mechanical Engineers with design experience in light mechanisms including servo-mechanisms, knowledge of hydraulics an advantage. Candidates must normally be natural born British subjects of natural born British parents with first or second class honours degree or equivalent high professional attainments. Salaries (Men) S.S.O., £1070-£1245; S.O., £513-£925, London rates. Somewhat lower in Provinces. Appointments unestablished (with F.S.S.U.), some opportunities to compete for established posts.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A 344/5A. L 7

THE PAISLEY TECHNICAL COLLEGE.
(CENTRAL INSTITUTION).

Applications are invited for the following appointments :

MECHANICAL ENGINEERING:

SENIOR LECTURER: Salary scale, £1010 by £50 to £1210.

GRADE I LECTURER: Salary scale, £760 by £30 to £910 by £50, to £1060 by £50 to £1160.

GRADE IIA LECTURER: Salary scale, £690 by £30 to £990.

CIVIL ENGINEERING:

GRADE IIA LECTURER: Salary scale, £690 by £30 to £990.

Applicants for the Senior Lecturer and Grade I posts should have industrial or research and teaching experience at university degree or H.N.C. level. For the Grade IIa posts applicants need not have teaching experience. All applicants should have an honours degree or equivalent qualification. The salary scales are under immediate review which will apply as from 1st April, 1956. Successful applicants will be given a placing on the scales appropriate to approved experience. Further particulars may be obtained from the undersigned.

H. N. HENRY,
PRINCIPAL. L 33

CANTERBURY EDUCATION AUTHORITY.

CANTERBURY TECHNICAL COLLEGE.

Applications are invited for the following full-time new appointments, for 1st September, 1956, for this Regional College:

1. **ASSISTANT FOR AUTOMOBILE ENGINEERING WORK** with students taking the Service Mechanics', Technicians', and Electricians' Courses. Ability to help with Agricultural Machinery would be an additional recommendation. Qualifications: City and Guilds Full Technological Certificate; recent industrial experience in the Motor Vehicle Repair Trade essential.

2. **ASSISTANT FOR ELECTRICAL INSTALLATION WORK** with students taking Courses " B " and " C " of the City and Guilds. Qualifications: City and Guilds Course " B " and Course " C " Certificates, together with Ordinary National Certificate in Electrical Engineering. Industrial experience essential. A knowledge of flameproof equipment an additional recommendation.

The appointments are Grade " A " on the Burnham Scales for Establishments for Further Education, i.e., £450 by £18 to £725 per annum, with appropriate allowances for Degree, training and approved Industrial experience.

Excellent opportunities for advancement exist in this rapidly developing Regional College for which an extensive building programme is approved.

Further particulars and Forms of Application, which should be returned as soon as possible, may be obtained from the PRINCIPAL, TECHNICAL COLLEGE, LONGPORT, CANTERBURY.

N. POLMEAR,
CHIEF EDUCATION OFFICER.
EDUCATION OFFICES,
78 LONDON ROAD,
CANTERBURY, KENT. L 60

GOVERNMENT OF CYPRUS.

CHIEF INSPECTOR OF FACTORIES (MALE OR FEMALE) required to organise and supervise the observance of labour legislation relating to workplaces, to conduct legal proceedings when necessary, prepare reports and train subordinate staff. Sound experience in Supervisory capacity of the application of United Kingdom factory laws and regulations required with, preferably, engineering qualifications of degree standard.

Post permanent and pensionable or on three-year contract. Salary scale £1353 to £1634 plus 10 per cent. cost-of-living allowance, and, if on contract a gratuity. Quarters at low rental. Free passages. Generous leave. Free medical attendance. Low Income Tax.—Further particulars and application forms from DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, GREAT SMITH STREET, S.W.1, quoting BCD 132/17/01. Closing date for the receipt of initial enquiries May 5th, 1956. K 900

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

ENGINEERS AND PHYSICISTS (PARTICULARLY WITH ELECTRONICS) required in Experimental Officer and Assistant Experimental Officer grades in Experimental Establishments in London, Portsmouth, Weymouth areas, Cheltenham and Scotland. Candidates must normally be natural born British subjects of natural born British parents, with minimum of H.S.C. (Pass degree, H.N.C. or near equivalent an advantage). London salary: (men) E.O. £790-£960, A.E.O. £320 10s.-£700 (according to age). Appointments unestablished, but opportunities to compete for established posts.—Application forms from M.I. & N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A214/5A. K 907

THE BRITISH HYDROMECHANICS RESEARCH ASSOCIATION is building up a school of experts in fluid mechanics who are to be capable of applying academic knowledge, supplemented by research, to a wide range of industrial problems.

The work is interesting and varied, covering flow problems in the process industries, chemical plant, power station and civil engineering structures, etc.; the scientific investigation of rotodynamic machines, cavitation, the hydraulic transport of coal, high pressure hydraulic machinery, automatic controls, and the physics of sliding surfaces in seals and glands.

A few well paid vacancies (£600 to £1000) are available for **YOUNG HONOURS GRADUATES IN ENGINEERING, PHYSICS OR MATHEMATICS** who can take the initiative in applying scientific fluid mechanics to industrial problems, and who preferably have some facility in the lucid exposition of their work. The work of the staff brings them in close contact with both industry and the Universities and opportunities arise from time to time for transfer to senior positions with the Association's member companies. There are also some vacancies for good research assistants with laboratory experience.

Successful applicants will be eligible to rent new houses or flats in Harlow.

Send full details to DIRECTOR OF RESEARCH, BRITISH HYDROMECHANICS RESEARCH ASSOCIATION, HARLOW, ESSEX. G 612

CENTRAL ELECTRICITY AUTHORITY.
EASTERN DIVISION.

Applications are invited for the following appointments in the Generation (Construction) Department at Divisional Headquarters in North London:—

CIVIL AND STRUCTURAL DESIGNER DRAUGHTSMEN.

Salary N.J.B., Schedule "D," within the range of Grades 3/4, £787 by £20 to £1008 per annum including London Weighting.

The commencing salary will depend on experience and qualifications.

The candidates appointed will be required to undertake civil and structural design work, and applicants should have had experience in the design and detailing of reinforced concrete structures for heavy plant, culverts, etc., and structural steelwork as applied to industrial buildings.

Applications stating age, qualifications and experience should be sent to the CONTROLLRE, CENTRAL ELECTRICITY AUTHORITY, EASTERN DIVISION, NORTHMET HOUSE, SOUTHGATE, N.14.

W. N. C. CLINCH,
Controller. K 881

STATES OF JERSEY.

SEWERAGE BOARD.

Applications are invited for appointments in the office of the Consultant Engineer to the Sewerage Board, as follows:—

(*a*) **AN ASSISTANT ENGINEER** at a commencing salary within the range £900 to £1000 a year. The principal duties will be the design of trunk sewers in connection with the Island Main Drainage Scheme and applicants should be competent to handle all phases of such work up to the tendering stage. Applicants should preferably be between 25 and 35 years of age and have passed sections A and B of the Institution of Civil Engineers examination or have some equivalent qualification.

(*b*) **TWO DRAUGHTSMEN** at a commencing salary within the range £400 to £500 a year. Applicants should be competent draughtsmen able to plot surveys and make finished drawings from dimensioned sketches. Ability to take levels and a knowledge of surveying would be an advantage. One appointment will be for general drawing office duties in connection with the design of new works, while in the case of the other the principal duties will involve taking measurements, plotting and making records of works.

The appointments will be temporary and terminable by one month's notice on either side.

Applications, stating age, whether married or single, giving full details of training, qualifications, present and previous appointments and accompanied by copies of two recent testimonials, must be delivered not later than 30th April, 1956, to the GREFFIER OF THE STATES, STATES' GREFFE, JERSEY, C.I.

The States of Jersey can undertake no responsibility for the provision of housing accommodation. K 920A

HANDBOOK
of fastening and joining of METAL PARTS

V. H. LAUGHNER and A. D. HARGAN

This complete manual collects together much helpful information on methods of joining metal parts. It will enable mechanical design and production departments to compare different ways of fastening and assembling any product. The use of screw thread and nuts, different types of welding, collars, couplings, keys, brazing and soldering are described in detail. Additional chapters cover standards, the suitability of various methods for dissimilar metals, and data on strengths.

11 x 8½ inches 656 pages 112s 6d

ELECTRONIC COMPUTERS
and management control

GEORGE KOZMETSKY and PAUL KIRCHER

A non-technical guide to the use of electronic computers in business, describing how they work and the many ways in which business executives can profitably use them. It examines the problems of management planning, and shows how to decide which electronic equipment is best suited for obtaining information in different organisations. The social implications of automation in the office are considered in relation to management, unions, workpeople and the community generally.

9 x 6 inches 275 pages approx 37s 6d

To be published shortly by **McGRAW-HILL**

Instructor Branch
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Why not utilise your scientific and professional knowledge and at the same time enjoy the comradeship of service life and see the world with the Royal Navy.

The Instructor branch offers Short Service commissions to graduates in Mathematics, Physics, Engineering, Chemistry, Metallurgy, History and English and to non-graduates with teaching experience in Science subjects.

The work of the Instructor Officer is fundamental to the Fleet and covers the widest field of active operational and academic duties ashore and afloat. Instructor officers are also the meteorologists of the Royal Navy.

Note also:—

★ Undergraduates in final year may apply.

★ Short Service Commissions may be for 3, 4 or 5 years.

★ Taking a Short Service Commission fulfils your obligation for National Service.

★ £300 tax free gratuity after 3 years and *pro rata* for longer.

★ All Short Service Officers may apply for permanent commissions.

★ Candidates must be British subjects, sons of British parents, under 36 years of age and medically fit.

For further details apply to

DIRECTOR,
NAVAL EDUCATION SERVICE (P.E),
ADMIRALTY, LONDON

(PE), K976.

Classified Advertisements continued on Page 4

THE COLLEGE OF AERONAUTICS.

Applications are invited for the **PERRING SCHOLARSHIP IN AERONAUTICS,** valued £400 per annum, tenable at The College of Aeronautics. The successful candidate will be admitted to the two-year course at the College.

Applicants should preferably be honours graduates or final year under graduates in engineering, mathematics or physics ; applications from non-graduates with comparable qualifications will also be considered. Candidates must be British subjects domiciled in the United Kingdom.

Forms of Application and statement of conditions will be forwarded on written application to:

THE WARDEN,
THE COLLEGE OF AERONAUTICS,
CRANFIELD,
BLETCHLEY,
BUCKS.

The closing date for the receipt of applications is 18th May, 1956. K 997

THE NIGERIAN RAILWAY CORPORATION invite applications for appointment as **ASSISTANT ENGINEER** in the Civil Engineering Department to take charge of a sub-District or medium sized capital works. Applicants should preferably have had approved experience in Railway Engineering, including bridge, and general building construction, and possess initiative, sound judgment and strong physique. They should be Corporate Members of the Institution of Civil Engineers or possess an Engineering degree recognised as granting exemption from Sections I and II of the A.M.I.C.E. examination.

Appointment will be either on probation in a permanent post in the salary range £850-£1600 plus £300 overseas inducement pay per annum or on Contract in the same range plus a gratuity based on 20 per cent. of the total salary plus overseas pay payable at the end of each tour of satisfactory service, or on final completion of service. The point of entry will be dependent on age, qualifications and experience.

Terms of service provide for tours of fifteen months, free first class passages both ways for the selected candidate and his wife, annual maintenance allowance of £75 each in respect of a maximum of two children while in United Kingdom, or actual cost of their passages if under 18 years of age, part furnished quarters at low rental and the grant of leave at the rate of seven days per completed month of service. Outfit allowance of £60.

Applications should be addressed to the LONDON REPRESENTATIVE, NIGERIAN RAILWAY CORPORATION, 11, MANCHESTER SQUARE, LONDON, W.1, giving personal particulars, qualifications and experience. K 883

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE.

Principal: C. L. OLD, B.Sc. (Eng.), M.Sc.Tech.

DEPARTMENT OF ELECTRICAL ENGINEERING.

Applications are invited for the post of **HEAD OF THE ABOVE DEPARTMENT.** Duties to commence on 1st September, 1956.

Candidates must have had good teaching and industrial experience. Evidence of ability to initiate and conduct research will be an advantage. The Department offers work at all levels, including four-year sandwich courses and University degrees.

Salary in accordance with the Burnham Technical Report, Grade III, Head of Department scale.

Further particulars and application forms may be obtained from the undersigned (s.a.e.).

G. W. R. LINES,
CLERK TO THE GOVERNORS. L 5

THE UNIVERSITY OF SOUTHAMPTON.

Applications are invited for the following posts:

DEPARTMENT OF AERONAUTICAL ENGINEERING.

SENIOR RESEARCH FELLOW. Salary, £1350 by £50 to £1650. Candidates must be over 26 and experience in fundamental research is essential. The person appointed will be expected to supervise generally the design of new high speed laboratory equipment and to take a leading part in research.

LECTURER. Salary £650 by £50 to £1350. A good Honours degree in Engineering, Physics or Mathematics or equivalent qualification is essential. Research experience is desirable. The person appointed will be expected to lecture in one or more of the subjects Aircraft Structures, Aerodynamics and Mathematics and to take part in research.

RESEARCH ASSISTANTS. Salary, £550-£650, or higher if justified by qualifications and experience. An Honours degree in Physics or Engineering or equivalent qualification is essential. The persons appointed will be required to take part in initial investigations in (i) the construction of a hypersonic shock tube and (ii) helicopter blade oscillations and will be encouraged to study for higher degrees.

DEPARTMENT OF CIVIL ENGINEERING.

LECTURER. Salary, £650 by £50 to £1350. A good Honours degree is essential. Industrial and/or research experience desirable. The person appointed will be encouraged to study for a higher degree.

DEPARTMENT OF ELECTRICAL ENGINEERING.

LECTURER. Salary, £650 by £50 to £1350. A good Honours degree, including heavy current subjects is essential. Industrial and teaching experience desirable. Acquaintance with high tension testing and/or modern servo-mechanisms, and/or heavy current analogue computers would be an additional recommendation.

DEPARTMENT OF MECHANICAL ENGINEERING.

LECTURER. Salary, £650 by £50 to £1350. A good Honours degree is essential. Experience of gas turbine work would be an additional recommendation.

All the foregoing posts, with the probable exception of the Research Assistantships, will carry F.S.S.U. and Children's Allowances. Initial placing on appropriate scale subject to qualifications and experience. Further particulars should be obtained from the SECRETARY AND REGISTRAR, to whom applications (6 copies) should be sent not later than 30th April, 1956. L 4

SCHOOL OF ENGINEERING, WASHINGTON UNIVERSITY, ST. LOUIS, MISSOURI, U.S.A., has vacancies in the departments of engineering drawing and mechanical engineering for

INSTRUCTORS AND ASSISTANT PROFESSORS

as either permanent or temporary appointments to teach in the following areas: engineering drawing, machine design, heat power engines, heat transfer and fluid mechanics. Men with university degrees are invited to submit their qualifications, education, and experience. Successful candidates may elect to pursue work towards advanced degrees.—Applications should be submitted to PROFESSOR H. E. GRANT, WASHINGTON UNIVERSITY, ST. LOUIS 5, MO., U.S.A. L 40

PORT OF BRISTOL AUTHORITY.

Following vacancies exist in Engineer-in-Chief's Department, Avonmouth Docks.

(*a*) **SECOND ASSISTANT ENGINEER (ELECTRICAL).** Salary Grade, APT. VI, £880/1080 per annum.

Candidates should have served an approved apprenticeship and should be at least Graduate Members of the Institution of Electrical Engineers. University degree and some experience of mechanical engineering added advantages.

Duties of section include installation, operation and maintenance of distribution and utilisation electrical equipment and preparation of specifications, estimates, etc., for new work at Avonmouth Bristol and Portishead. Electrical consumption is rising and has reached 16,000 kVA and 70 million units per annum.

(*b*) **SECOND ASSISTANT ENGINEER (MECHANICAL).** Salary Grade, APT VI, £880/1080 per annum.

Candidates should have served an approved apprenticeship and should be at least Graduate Members of Institution of Mechanical Engineers. University degree and some experience of electrical engineering added advantages.

Duties of section include installation and maintenance of mechanical equipment (cranes, locomotives, etc.), and preparation of specifications, estimates, etc., for new work.

(*c*) **ENGINEERING ASSISTANT (CIVIL).** Salary, Grade APT I, £530/610 per annum.

Successful applicant will be engaged on general civil engineering work. Preference given to a prospective Associate Member of Institution of Civil Engineers.

(*d*) **TWO SENIOR DRAUGHTSMEN AND ONE DRAUGHTSMAN.** Salaries, Grade APT V, £795/970 per annum, and Grade APT IV, £710/885 per annum, respectively.

Applicants for senior positions should have good knowledge of general civil engineering and building construction and be capable of preparing drawings for major schemes with minimum supervision. Similar experience required for the Draughtsman position commensurate with salary offered.

Applicants who have specialised in building construction will be considered for one of the positions.

There are prospects of promotion in due course.

Conditions Applicable to all Vacancies.

Commencing salary within the ranges quoted will depend upon experience. Successful candidates required to pass a medical examination before appointment and to serve probationary period of six months. Appointments are pensionable in accordance with provisions of the Local Government Superannuation Act, 1953.

Applicants must disclose whether they are related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications, stating age, qualifications, experience, etc., and enclosing, if possible, copies of recent testimonials, must reach undersigned by 10.0 a.m. on 4th May, 1956.

N. A. MATHESON,
ENGINEER-IN-CHIEF,
AVONMOUTH DOCKS, BRISTOL. L 2

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

NUCLEONIC INSTRUMENT DEVELOPMENT. **ELECTRICAL ENGINEER** required. H.N.C. minimum qualifications with at least three years experience in electronics. Permanent appointment with interesting possibilities, depending mainly on the individual—Applications should be addressed to THE PERSONNEL OFFICER, PHILIPS BALHAM WORKS, LTD., 45, NIGHTINGALE LANE, S.W.12. G 639

Leading manufacturers of container closures in the Midlands have a number of vacancies for ambitious **DESIGN DRAUGHTSMEN** preferably with some experience in this or a similar sphere. Interesting work with excellent salary and every opportunity for promotion to senior position in a rapidly growing organisation. Write in confidence with details of experience, positions held, salary required; to P. A. METAL CLOSURES LIMITED, BROMFORD LANE, WEST BROMWICH. G 627

ROLLS-ROYCE
AERO ENGINE DIVISION.
(Scottish Factories.)

ROLLS-ROYCE LIMITED have established a Gas Turbine Design and Development Division in a new factory at East Kilbride, situated approximately eight miles from Glasgow.

Vacancies exist for the following categories:

DEVELOPMENT AND TECHNICAL SERVICE ENGINEERS.

For development work on engines, fuel systems, and accessories to improve performance and extend engine life. Applicants should be of degree standard preferably with some experience of this type of work or have had considerable experience of development work in this field.

DESIGN DRAUGHTSMEN.

Applicants should have minimum technical qualifications of H.N.C. (Mechanical or Production Engineering) and some design experience.

DETAIL DRAUGHTSMEN.

Applicants should have previous drawing experience in light mechanical engineering, specialised training on aero gas turbine work will be provided where necessary.

Housing accommodation in the new town of East Kilbride will be supplied if required after a three months probationary period.

Application forms are available from the PERSONNEL MANAGER, ROLLS-ROYCE LIMITED, HILLINGTON, GLASGOW, S.W.2, and envelopes should be marked TE/25. K 980

LEADING MANAGEMENT CONSULTANTS have several vacancies for **QUALIFIED ENGINEERS WITH EXECUTIVE EXPERIENCE** and with initiative to act as Consultants after training. Age not over 40. Salary scale, £1500 to over £2200 p.a., with considerable further prospects to exceptional men. Superannuation and expense allowances.—Full details of qualifications and experience to BOX K 998, Offices of ENGINEERING.

ENGINEERING DRAUGHTSMEN are required immediately for General Developments at Iron and Steel Works. People accustomed to taking responsibility are required preferably with technical training up to H.N.C. or degree standard, who should have sound experience in General Engineering. Good salaries will be paid to the right people. Apply to BOX L 51, Offices of ENGINEERING.

CHAPMAN & HALL

Ready 24 *April*

FLUIDIZATION

Edited by

Donald F. Othmer

(Head, Department of Chemical Engineering
Polytechnic Institute of Brooklyn, N.J.)

Size: 9¼" × 6" *231 pages* *Illustrated* *56s. net.*

This work describes in full book form the concept of fluidization and its applications to chemical engineering. It presents scientific and engineering considerations in the words of many of the engineers who have originated and developed this important technique.

DESIGN OF PIPING SYSTEMS

by

The M. W. Kellogg Company
and Subsidiaries

Second Edition—Revised and Enlarged

Size: 11¼" × 8½" *365 pages* *Illustrated* *120s. net.*

This second edition of a work which was originally published privately, has been completely re-written and substantially expanded. It offers a modern, comprehensive account of the entire subject of structural design of piping systems. It includes the most complete and detailed treatment of the thermal expansion problem so far published, and shows how this treatment is extended to calculating the effects of uniform loading, such as that due to weight or wind.

★

Ready Shortly

AUTOMATIC PROCESS CONTROL FOR CHEMICAL ENGINEERS

by

Norman H. Ceaglske

(Professor of Chemical Engineering, University of Minnesota.)

Size: 9¼" × 6" *228 pages* *Illustrated* *54s. net.*

A basic, systematic approach to the analysis and design of control systems from the chemical engineering viewpoint.

37 ESSEX STREET, LONDON, W.C.2

VICKERS-ARMSTRONGS
(Aircraft) LIMITED

VICKERS-ARMSTSONGS (AIRCRAFT) LTD., WEYBRIDGE, have vacancies for:

(a) **PLANNING ENGINEERS** with experience on jig and tool control. Applicants must have a sound practical knowledge and be up-to-date on both jig and tooling methods.

(b) **TECHNICAL CLERKS,** with some knowledge of jig and tool engineering, to assist the above Planning Engineers.

Applications, quoting date and prefix letter of advertisement to: EMPLOYMENT MANAGER, VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED, WEYBRIDGE, SURREY. L 17

STRUCTURAL ENGINEER with wide experience of the design and detailing of all types of steel structures and with administrative experience required to act as deputy to the Chief Engineer by large firm of London Consultants. The firm is expanding and the vacancy offers excellent opportunities for the right type of man.—Write in confidence giving details of previous experience and salary required to BOX No. 355, GLOVER2 ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G 635

ENGLISH ELECTRIC

STEAM TURBINE DESIGN ENGINEERS are required by English Electric, Rugby, for a rapidly expanding programme of Steam Turbine work, ranging from the smallest to the largest type of land turbines. The work is of a permanent nature and offers considerable scope to qualified engineers with some experience of turbine design problems.—Write in confidence, giving full details of previous experience, to DEPT. C.P.S., 336/7, STRAND, W.C.2, quoting Ref. 1200C. K 988

WANTED

DRAUGHTSMEN to design in aluminium for sale development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £900 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO. LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

Rocket Division of Armstrong Siddeley Motors has really good vacancies for **DESIGNERS AND DRAUGHTSMEN** intent on furthering their career in this new branch of propulsion. Applicants must have had minimum of three years drawing office experience and preferably hold at least a Higher National Certificate in Mechanical Engineering. Drawing office experience, however, is preferable to academic qualifications. Due to new projects and consequent expansion of departments prospects for men of the right calibre are unusually good. This is a fine opportunity to enter on the ground floor of new and fascinating work with far reaching implications. Initial salary range £13 10s. to £16 10s. per week.—Apply for a personal interview with our Chief Designer, Rocket Division by writing to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY, quoting reference RD/DD. G 631

SAFETY OFFICER. A large firm of Engineers specialising in the erection of heavy industrial plant and civil engineering construction requires the services of a Safety Officer. The post involves control of the accident prevention work on contract sites in the U.K. An engineering background is essential and technical qualifications would be an advantage. Candidates should have had previous experience of safety work and must be fully acquainted with the application of the Factories Act and Statutory Regulations. Only candidates who can fulfil these requirements will be considered and a commensurate salary will be paid to the right man. An interview in confidence will be arranged with suitable candidates and full details of duties, responsibility, etc., will be explained. The post is superannuable. The successful candidate will operate from an office in the North of England but travelling to sites is necessary.—Please write full details to BOX K 366, Offices of ENGINEERING.

SHORT BROTHERS AND HARLAND LIMITED

THE MECHANICAL SECTION
of the
RESEARCH DEPARTMENT
has vacancies for

SENIOR DEVELOPMENT ENGINEERS, DEVELOPMENT ENGINEERS AND TECHNICAL ASSISTANTS

for

work on guided missiles and navigational systems, automatic pilots, flight simulators, servos and automatic control developments. Applicants should preferably have had some experience of hydraulic or pneumatic servos, precision mechanisms, or systems employing such components.

QUALIFICATIONS: Senior Engineers: Engineering Degree, with several years suitable experience, and the ability to control a development team. Engineers: Degree or equivalent, with some industrial experience. Technical Assistants: H.N.C. or equivalent, with good practical experience in appropriate field.

Assistance with housing and with removal expenses.

Interview either in London or Belfast.

Apply to:—

STAFF APPOINTMENTS OFFICER, SHORT BROTHERS & HARLAND LIMITED, P.O. BOX 241, BELFAST, quoting S.A.134, and stating salary required. K 864

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD

ARMAMENTS DIVISION.

TECHNICAL ASSISTANTS

A number of Technical Assistants are required for interesting work in Power Supplies in Guided Weapons.

Qualifications should include a degree in Engineering or H.N.C. together with a minimum of 2 years experience in test and development work.

Pleasant working conditions and amenities are provided, and an attractive superannuation scheme is in operation. The work is of a permanent character in a new and expanding field and salaries are good.

All replies should be addressed to:—
TECHNICAL APPOINTMENTS OFFICER
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT, LTD.,
BAGINTON,
Nr. COVENTRY,
quoting reference P/6/ARM/TAO K 860

GRADUATE ENGINEERS FOR CONSTRUCTION

Applications are invited for the following position with Major Oil Company Middle East.

(1) **ENGINEERING ASSISTANT TO CONSTRUCTION SUPERINTENDENT (CIVIL OR MECHANICAL ENGINEER)** with over five years experience field engineer construction process plant, industrial and general building projects. Familiar field organisational problems and with good working knowledge general construction and equipment. Age 30-40. Commencing salary £1580 p.a. up according experience, etc.

(2) **FIELD ENGINEERS (4) (CIVIL OR MECHANICAL)** with over two years experience in either general building projects such as housing, public buildings and utility installations or in oil refinery or chemical process plant installation and utilities. Must be familiar with job planning, scheduling and general construction techniques. Age about 30. Commencing salary £1245 p.a.

In addition to salaries quoted, free air conditioned accommodation and adequate living allowance provided with medical attention, kit allowance, pension plan and paid home and local leaves.—Apply (quoting CON) to BOX G 647, Offices of ENGINEERING.

AN INTRODUCTION TO FLUVIAL HYDRAULICS

by S. Leliavsky, Ph.D.

Demy 8vo 257 pages. Illustrated 30s. net.

"From all engineers concerned with the management and behaviour of rivers, and particularly by those who have studied Dr. Leliavsky's first volume on the subject of 'Irrigation and Hydraulic Design,' the advent of this smaller book is assured of an enthusiastic welcome. The purpose of the book is to review notable contributions that have hitherto been offered towards the solution of problems relating to the behaviour of natural rivers or of artificial canals which flow on a bed consisting of granular material fed to the canal at its off-take from the parent river. . . .

The author's qualifications for undertaking such a survey reside not only in his long experience both as a practical engineer responsible for the design of important hydraulic structures in Egypt and Russia (and also, in the academic field, as a professor of irrigation in Egypt), but also in the amazingly wide scope of his reading of original papers in many languages and a profound understanding of the methods and ideas presented therein. He has a remarkable gift for lucid exposition in making a keenly critical but always impartial and unbiassed assessment of the significance and validity of the results obtained and conclusions formed by others working in the broad field of hydraulic research.

The great merit and value of the book lies in the author's selection and arrangement of material and in his enlightening comments and criticism on attempts made to solve the many problems of river flow. For the engineer confronted with problems of river-training it will be found an indispensable book of reference."

(*Engineering Feb* 17, 1956)

CONSTABLE & CO. LTD.
10 ORANGE STREET, LONDON W.C.2

DRAUGHTSMEN
and
DESIGNERS

Applications are invited for the following positions on the regular Mechanical Engineering drawing office staff of a large iron and steel organisation:—

1. **DESIGNER,** fully experienced and accustomed to medium and heavy engineering equipment.
2. **SENIOR DRAUGHTSMAN,** with similar experience to the above.

There are also openings for draughtsmen of lesser seniority who have completed their National Service and have, including engineering training, not less than 5 years drawing office experience.

Nominal hours are 38 per week with payment for overtime to draughtsmen grades. A contributory superannuation fund is in operation.

Apply giving full particulars of engineering experience and training, also technical education and qualifications, stating salary required and when at liberty to BOX K 895, Offices of ENGINEERING.

Classified Advertisements continued on Page 6

ROLLS-ROYCE

Nuclear Energy Projects

Engineers and Physicists are required by Rolls-Royce to work on an interesting experimental programme for their new projects in Nuclear Energy.

Opportunities exist for both senior and junior men with good degrees, to work on problems of heat transfer, fluid mechanics, applied mechanics and on the development of mechanism for use in unusual environments.

The vacancies to be filled are in a young and expanding organization situated in pleasant surroundings near Derby, where technical staff can work unhampered by administrative detail.

Write to OH/Msn (N.13) ROLLS-ROYCE LTD
P.O. BOX, 31 DERBY

K 977

VICKERS-ARMSTRONGS
(Aircraft) LIMITED

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED,
WEYBRIDGE, SURREY,

require:

(*l*) **DRAUGHTSMEN (SENIOR, INTERMEDIATE AND JUNIOR)** for the design of electrical and radio systems, instruments, structures, power plants, installations, mechanism, furnishing, etc. Aircraft experience not essential.

(*m*) **FLIGHT TEST INSTRUMENT TECHNICIANS** for the making, calibrating and servicing of prototype aircraft test instrument installations.

(*n*) **AIRCRAFT SPARES SCHEDULE COMPILERS**—suitable ex-R.A.F. personnel required or civilians with airframe maintenance experience.

(*o*) **INSPECTORS** for assemblies, tinsmiths, details and other branches of aircraft production.

The Company will be interested also in considering applications from other experienced Technicians and Tradesmen in occupations applicable to the Aircraft Industry.

Applications, quoting date and prefix letter of advertisement to:

EMPLOYMENT MANAGER,
VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED,
WEYBRIDGE WORKS, WEYBRIDGE, SURREY. L 18

DESIGN ENGINEER for GAS TURBINE Drawing Office, for thermo dynamic and mechanical design calculations, etc. Appl cants with degree preferable, but not essential. Candidates must be corporate members of the Institution of Mechanical Engineers, with sound technical background and some experience in Industrial Gas Turbines, Steam Turbines or Aero Engines, etc. Salary according to age and qualifications.—Application forms can be obtained from the EMPLOYMENT MANAGER, RUSTON & HORNSBY LIMITED, LINCOLN. L 31

MECHANICAL ENGINEERS

are invited to apply for number of DESIGN posts with the ENGLISH ELECTRIC COMPANY'S GUIDED WEAPONS DIVISION, LUTON, BEDS.

One Engineer would be engaged on mechanical design and engineering of basically electronic units. Other engineers would design a variety of mechanical devices, and in particular mechanical components of servo systems.

Modern laboratories provide ideal working conditions in a good research atmosphere, with attractive salaries for the right men. In selected cases housing assistance may be possible. These posts are pensionable after a qualifying period.

Applications, which will be treated in strict confidence, to DEPT. C.P.S., 336/7, STRAND, W.C.2, quoting Ref. 1000J.

K 987

DRAUGHTSMAN DESIGNERS required for UNILEVER LTD., LONDON OFFICE. Workshop trained. At least O.N.C. standard for design and planned layout of factory plant. Candidates should have experience in general mechanical engineering. Pension Scheme and canteen.—Send particulars of age, training and experience in full to: PERSONNEL DIVISION (WAD 114), UNILEVER LTD., UNILEVER HOUSE, LONDON, E.C.4. L 3

CONTRACTS ENGINEERS.

A. REYROLLE & COMPANY LTD., of Hebburn, County Durham, who are the largest firm of switchgear specialists in the world, have vacancies for **CONTRACTS ENGINEERS,** both for Home and Overseas contract work on E.H.V. switchgear. In addition, vacancies also exist for Contracts Engineers to handle work in connection with major industrial installations and medium voltage switchgear. The appointment would be for work at Hebburn and it is customary for the Company to appoint engineers for duties in the overseas and home Area Offices from engineers trained at Hebburn. The work requires initiative and affords the engineer individual responsibility. It is interesting and varied and calls for ability to conduct both technical and commercial negotiations. The desirable qualifications are therefore a Degree or a Higher National Diploma or Higher National Certificate, but candidates having an Ordinary National Certificate who are still proceeding with studies could be considered specially. Applicants need not have specialised previously in switchgear, and if necessary, suitable introductory training would be arranged.—Applications, giving full particulars of technical training and previous experience, should be forwarded to the CONTRACTS MANAGER, A. REYROLLE & CO., LTD., HEBBURN, marked "Personal." L 19

J. MOWLEM & CO., LTD. have vacancies in their Concrete Laboratory for a **CONCRETE ENGINEER** and an **ASSISTANT CONCRETE ENGINEER.** These vacancies are permanent and form an excellent opportunity for the right type of man. Salary according to age and experience. For the junior position previous experience in this type of work is not essential as adequate training will be given.—Apply, giving all details in own handwriting to BOX L 20, Offices of ENGINEERING.

DRAUGHTSMAN, MECHANICAL, required for work on heavy mechanical engineering and pulverised fuel equipment. Experience this class of work would be useful. Voluntary superannuation scheme available working week five days. Please reply, quoting experience. Salary approx. £800.—BOX L 41, Offices of ENGINEERING.

ENGINEERING DRAUGHTSMAN required immediately for large developments at Iron and Steel Works in the Midlands. Accustomed to taking responsibility, and preferably with technical training up to N.C. or H.N.C. standard. Should have a sound experience in general engineering.—Apply to BOX L 50, Offices of ENGINEERING.

INDUSTRIAL CONTROL GEAR ENGINEERING

The Industrial Control Department (Servo Section) of Metropolitan-Vickers Electrical Co., Ltd., is expanding and has vacancies for

GRADUATE ELECTRICAL ENGINEERS

with experience of magnetic and electronic amplifiers. A good technical knowledge of the theory of closed loop control systems is necessary and some background on conventional (open loop) industrial control gear practice would be an advantage.

The work involves design and application of closed loop control for a wide variety of industrial motor drives, e.g., for Steelworks, Mine Winders, Paper-making Machinery and Machine Tools, etc.

The posts are permanent and pensionable.

Apply for Application Form, quoting reference "Y.4," to :—

Personnel Manager,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
Trafford Park, Manchester 17. L 45

INDUSTRIAL CONTROL DRAUGHTSMEN AND TRAINEES

Required for the design of Motor Control Gear and associated equipment. Previous experience in this class of work preferred, but not essential. Experienced Draughtsmen on electrical and/or mechanical work are invited to apply.

Draughtsmen are also required for the preparation of wiring diagrams.

Trainees, of not less than S.2, O.N.C. standard or those who are now taking S.2 will be considered for all of the above. The positions are permanent and the work offers excellent opportunities.

Pension Scheme in operation.

Full canteen facilities.

Apply for application form, quoting reference "U.4," to:—

PERSONNEL MANAGER,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
TRAFFORD PARK, MANCHESTER, 17.

K 861

MECHANICAL ENGINEER to take charge of Workshop for services and development at Research Station. Served apprenticeship. Higher National Certificate in Mechanical Engineering or equivalent. Must be capable of original thinking. Location Surrey countryside. Pension scheme. Profit Sharing Scheme. Canteen.—BOX K 995, Offices of ENGINEERING.

The following appointments are available in

THE ATOMIC ENERGY DEPARTMENT

of

THE GENERAL ELECTRIC COMPANY LIMITED

at Erith, Kent

for development and Design work on

NUCLEAR POWER STATIONS

Ref. A.E.D.1

MECHANICAL ENGINEERS with experience in the design and layout of large steam Power Stations. Applicants should have a degree in Engineering and not less than five years experience in this type of work.

Ref. A.E.D.2

A MECHANICAL ENGINEER with a first or second class honours degree who has specialised in stress analysis problems in complex steel structures.

Ref. A.E.D.3

MECHANICAL ENGINEERS, preferably with honours degrees, who have had experience in heat transfer research and heat exchanger design.

Ref. A.E.D.4

A MECHANICAL ENGINEER, preferably with a degree and with experience in the development of prototype mechanisms, to take charge of a laboratory where reactor control and fuel element handling equipment is now being tested.

Ref. A.E.D.5

DESIGNER-DRAUGHTSMEN with experience in Power Station layout, heat exchanger and pressure vessel design, and the design of mechanical control equipment and servo mechanisms.

Attractive salaries will be offered and the positions available afford excellent opportunities for advancement.—Apply giving age and details of training and experience to PERSONNEL MANAGER, THE GENERAL ELECTRIC CO., LTD., FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT.

K 866

DRAUGHTSMAN required for Engine Design Schemes on small high-speed diesels must have initiative and experience. Good salary. Pleasant working conditions. Pension Scheme.—Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES.

G 650

IMPERIAL CHEMICAL INDUSTRIES LIMITED, DYESTUFFS DIVISION, HEXAGON HOUSE, BLACKLEY, MANCHESTER, 9, has a vacancy for a **PURCHASING ENGINEER.** Candidates should be between 25 and 35 years of age, and should be in possession of Higher National Certificate or better qualification. Design and Works experience is desirable, and some experience in the purchasing of engineering products will be an advantage. K 983

TEXTILE MILL requires

ASSISTANT TO CHIEF ENGINEER

25-35 years of age with University degree or equivalent in Mechanical Engineering, with experience in similar position, to take charge of maintenance shops, electrical installation, drawings records. Permanent position with good prospects. Salary commensurate with qualifications. Pension scheme. Only first-class men need apply, stating age, qualifications, experience and salary required to :—

MANAGING DIRECTOR,
BRITISH DEPA CREPES LIMITED,
GLEBE MILLS,
HOLLINGWOOD, OLDHAM, LANCS.

K 880

JOSEPH LUCAS (ELECTRICAL) LIMITED intend to appoint a **DEPUTY CHIEF METALLURGIST** with a view to his subsequent promotion to Chief Metallurgist in charge of a staff of about forty. The applicant should, preferably, have an honours degree in metallurgy and be between the ages of 35 and 45. Experience in the field of light engineering is essential, and in quantity production a distinct advantage. He will be responsible for, and with the aid of specialists be expected to deal with the specification and testing of, incoming materials; production heat treatment, which includes heating in controlled atmosphere furnaces and by induction, carburising by the solid, liquid and gaseous methods, and nitriding; with welding, brazing and soldering, and with pyrometric control. He must have a knowledge of most kinds of cold-forming and machining processes. He will be required to advise metallurgically those who are responsible for engineering design, and to collaborate with those who have to maintain an unusually high level of quantity production. Special notice will be taken of an ability to write clear reports.—Apply to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL) LTD., GREAT KING STREET, BIRMINGHAM, 19, quoting reference PM/D/128.

K 986

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.
ARMAMENTS DIVISION.

SENIOR ELECTRONIC AND ELECTRICAL ENGINEERS.

A number of Senior Engineers both Electronic and Electrical are required for work associated with the flight trials of guided weapons.

The work is of a very varied and interesting character and includes system testing and the analysis of the behaviour of complex installations including mechanical and hydraulic components, in addition to electronic and electrical components.

A number of years' experience in electronic and/or electrical engineering is essential for these positions, and service experience of radar, radio and telecommunications is a very suitable qualification.

A university degree is not essential for these positions but practical experience and experience of experimental work is highly desirable.

These positions are responsible posts and carry attractive salaries and excellent prospects.

Pleasant working conditions and amenities are provided and an attractive superannuation scheme is in operation.

All replies should be addressed to:—

TECHNICAL APPOINTMENTS OFFICER,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.,
BAGINTON, NR. COVENTRY.

quoting reference FT/12/ARM/TAO.

L 47

BRITISH CELLOPHANE LIMITED,
BRIDGWATER, SOMERSET,

seeks **SENIOR AND JUNIOR DRAUGHTSMEN,** for both PERMANENT and TEMPORARY appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions Fund scheme for permanent appointments. Ref. No. E.48.Eg.

The TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ESTIMATOR (PERMANENT).—Applicants should have served an engineering apprenticeship and have technical education up to O.N.C. standard. The work involved will be on the preparation of material and labour specifications in connection with engineering work, electrical estimating experience an advantage. Ref. No. E.49.Eg.

ASSISTANT ENGINEER, age 23/30 (permanent).—Applicants should have an honours degree in mechanical engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant. Ref. No. E.50.Eg.

ASSISTANT ENGINEER, age 25/50 (permanent).—Applicants should have a university degree and have works experience, or be an A.M.I.Mech.E. The duties will be on development, improvement and maintenance of plastic films extrusion plant and ancillary equipment. Ref. No. E.45.Eg.

Write to the PERSONNEL OFFICER, stating full particulars and salary required, and quote Ref. Nos. as indicated.

L 32

DESIGN DRAUGHTSMEN. THE BRITISH DRUG HOUSES LTD. invite applications from suitably qualified men for interesting work in their Engineers' Drawing Office, on special machines and plant layouts for the Light Chemical Industry. Higher National Certificate in Mechanical Engineering and previous experience in this industry desirable but not essential. Men of mature age with suitable training and experience would be considered. Five-day week. Pension and Profit Sharing Schemes.—Write, stating age, experience and salary required, to STAFF MANAGER (REF.: B 8945), GRAHAM STREET, CITY ROAD, N.1.

K 985

West End London Consulting Engineers require now SEVERAL SENIOR AND JUNIOR ENGINEER DRAUGHTSMEN to prepare designs, contract drawings, specifications, etc., for heating, ventilating, boiler plant and allied mechanical services. Interesting work for factories, office blocks, hospitals, colleges, schools, etc. Opportunity for experienced men with initiative. Five-day week. One week's spring holiday in addition to usual summer two weeks. Bonus and optional superannuation scheme.—Write stating age, experience, qualifications and salary reqnired. BOX G 588, Offices of ENGINEERING.

WILTON ICI WORKS

MECHANICAL ENGINEERS

FOR ENGINEERS DIRECT from the University, or for trained Mechanical Engineers with industrial experience, the chemical industry provides opportunities for a satisfying and well paid career. At Wilton during the last ten years many plants of great technical interest have been erected and plans made for further continuous development over a number of years. Here there are vacancies for Engineers on design, construction, and operation, with opportunities for training and advancement to managerial positions.

THE CHANCE TO take part in this enterprise should particularly attract men graduating in 1956. Starting salaries are good and, should it be necessary, there are opportunities of gaining practical experience in a course which will initiate men into industry and be acceptable to the chartered engineering institutions.

THIS MODERN factory is situated at the foot of the Cleveland Hills within easy reach of the Yorkshire Coast. Working conditions are excellent and recreational facilities including golf, tennis and squash are available. After joining the staff, married men will receive a reasonable refund of removal (including travel) expenses; to assist in house purchase, facilities are available in approved cases for loans; in addition, legal charges may be advanced.

THE APPOINTMENTS are permanent and include membership of the Staff Pension Fund and participation in the Employees' Profit Sharing Scheme.

ANY ENGINEERING GRADUATE who is interested in a career which will combine interesting and productive work with prospects of steady progress should write to: STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, WILTON WORKS, MIDDLESBROUGH, YORKSHIRE, quoting advertisement reference ICI/X/285/b.

K 894

GRADUATE MECHANICAL ENGINEERS

who are keen to join a RESEARCH GROUP engaged in the study, design and development of hydraulic control valves, pumps, miniature high-speed turbines and auxiliary power systems are invited to apply for SENIOR and JUNIOR posts with the GUIDED WEAPONS DIVISION OF THE ENGLISH ELECTRIC CO., LTD., AT LUTON, BEDS.

These positions give scope for original work in Thermodynamics, Hydraulics and Servo mechanisms, and attractive salaries are offered to the right men. Housing assistance may be possible in certain instances.—Apply in strict confidence to DEPT. C.P.S., 336/7, STRAND, W.C.2, quoting Ref. 1000K.

L 71

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(a) Mechanical and By-Product Plant.
(b) Pipework.
(c) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3.

G 550

REGULATING SYSTEMS ENGINEERS.

Vacancies exist on the staff of an Engineering Department of the BRITISH THOMSON-HOUSTON CO., LTD., which is engaged in designing industrial regulating systems and servomechanisms. An electrical engineering degree, or equivalent academic qualification, is essential and some experience of feed-back control systems is desirable. The Department handles applications in a wide variety of industries and some specialised knowledge of a particular industry might be an advantage although this is not a requirement.

Applications should be in the Applicant's own handwriting, and should state age, qualifications, training and experience.

Apply: MANAGER, INDUSTRIAL ENGINEERING DEPARTMENT, THE BRITISH THOMSON-HOUSTON CO. LTD., RUGBY.

L 1

Classified Advertisements continued on Page 8

A.E.C. LIMITED require
DETAIL DRAUGHTSMEN. Experience of the motor industry an advantage. Modern offices and equipment, excellent opportunities for progress. Good salary offered, five-day week, pension scheme and canteen facilities.—Applications in writing, giving age, experience and salary required to STAFF RECORDS OFFICE, WINDMILL LANE, SOUTHALL, MIDDLESEX. K 877

ENGINEERING SERVICES DRAUGHTSMAN required by AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTS. Must be conversant with general services, design and layouts. This includes steam, hydraulic, compressed air, cooling water, space heating, etc. Sound opportunity for suitable man.—Applicants of H.N.C. standard or equivalent preferred, but others having the necessary experience are invited to apply to the CHIEF ENGINEER, with full particulars, age, etc. K 871

GENERAL ENGINEERING DRAUGHTSMAN required immediately in the Works Engineer's Department of THE AVON INDIA RUBBER CO., LTD., BRIDGEND. Permanent and sound position with expanding Company for a man who is prepared to work hard and adapt himself to growing industry with special purpose machinery and comprehensive engineering services. H.N.C. or equivalent. A.E.S.D. rates plus to suitable applicant.—Write, stating age, experience, etc., to PERSONNEL MANAGER. K 872

DESIGNER-DRAUGHTSMAN required with experience of Paper Converting and Aniline Printing Machinery. Ordinary or Higher National Certificate in Mechanical Engineering desirable. The work is varied and interesting, consisting mainly of development of existing plant.—Apply in writing stating age, experience and salary required to: DAILLEY AND COMPANY, LTD., GARMAN ROAD, NORTHUMBERLAND PARK, LONDON, N.17. K 873

ELECTRICAL LABORATORY ASSISTANT. Young men are required for prototype work on low voltage equipment for motor vehicles. Applicants should hold, or be studying for, O.N.C. (Electrical), although practical experience in similar work would be considered in its absence. Prospects of advancement into Design work exist for the right man.

Apply in writing giving full details of age and experience to PERSONNEL OFFICER, SIMMS MOTOR UNITS, LTD., OAK LANE, EAST FINCHLEY, N.2. K 886

THE BRITISH THOMSON-HOUSTON RESEARCH LABORATORY, RUGBY, require a **MECHANICAL OR ELECTRICAL ENGINEER** to assist in a programme of machining research with special reference to spark grinding and other applications of electro-erosion.—Applicants are invited to write to the DIRECTOR OF RESEARCH, BRITISH THOMSON-HOUSTON CO., LTD., RUGBY, giving details of age, qualifications and experience and quoting reference TJ. K 890

COST ACCOUNTANT required for Engineering Works at Speke, Liverpool. Age 35/45. Practical experience of standard costing essential. The post is pensionable with a good commencing salary and there are excellent prospects for an able man.—Reply, giving fullest information and an indication of salary to BOX K 330, LEE & NIGHTINGALE, LIVERPOOL. K 876

DRAUGHTSMEN required by NORTHERN ALUMINIUM COMPANY, LIMITED, BANBURY, OXON. Qualifications: H.N.C. preferred, but O.N.C. considered, workshop training an advantage. Permanent positions to suitable applicants. Pension and Life Assurance Scheme in operation, also welfare and sports facilities.—Applications in writing to PERSONNEL MANAGER, stating age, experience and salary required. K 856

IMPERIAL CHEMICAL INDUSTRIES LIMITED, PLASTICS DIVISION, has an immediate vacancy for a
DRAUGHTSMAN for work on the instrumentation of chemical and plastics plants. Candidates should hold the Higher National Certificate in mechanical or electrical engineering. Some experience of industrial instrumentation would be useful.

A good starting salary will be paid, beyond which there is scope for progressive remuneration.—Apply giving full particulars to THE STAFF MANAGER I.C.I., LTD. PLASTICS DIVISION, BLACK FAN ROAD, WELWYN GARDEN CITY, HERTFORDSHIRE. K 850

QUALIFIED ENGINEER/AGENT required by firm of Industrial Engineers to supervise the erection of a large contract in the North West area. Applicants must have good organising and administrative experience. Previous steelworks engineering experience will be an advantage but not essential. Excellent permanent prospects are offered after completion of the specific contract which will be of three years duration. House will be provided.—Please state age, salary required and full particulars of previous experience to BOX K 843, Offices of ENGINEERING.

COURTAULDS LIMITED, COVENTRY, require **INSTRUMENT TECHNICIAN** for work on the design, installation and operation of experimental automatic control equipment in the textile and Chemical Engineering fields. Previous experience in at least one branch of Mechanical and Electrical Industrial Instrumentation is preferred, but a candidate with Electrical Design and Drawing Office experience would be considered eligible.

The post is an interesting one in the Research and Development Department and offers excellent prospects of promotion in a rapidly expanding field. Qualifications equivalent to a Higher National Certificate in Electrical or Mechanical Engineering are preferred.—Applications in the first instance to the LABOUR OFFICER, MAIN WORKS. K 855

TWO ENGINEERING DRAUGHTSMEN required by AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTS, for mechanical equipment design work. Interesting and progressive situations offered to suitable applicants. H.N.C. standard or equivalent, but others with the necessary experience may apply to the CHIEF ENGINEER, with full particulars of age, etc. K 920B

Attractive Opportunities for Experienced Men

DAVY AND UNITED ENGINEERING COMPANY LIMITED

Due to our ever increasing production programme, Britain's largest builders of Rolling Mill and auxiliary plant offer the following vacancies to ambitious qualified men interested in heavy engineering. Every contract, whatever its size, has to be individually engineered so that the widest range of interest can be offered giving unlimited scope for ingenuity and initiative.

PROJECTS ENGINEERS — Engineers required with experience of blooming, structural and billet mills, and merchant bar and rod mills. The Projects Department covers the technical aspects of the Company's sales effort and the work involves the engineering for tendering purposes of customers enquiries, ranging from individual machines to complete mill plants.

GEAR ENGINEERS — Engineers required with experience in the design of heavy duty gears. The Gear Section is responsible for the design of a wide range of gears for all duties from small sizes up to 5,000 H.P.

DRAUGHTSMEN — Draughtsmen required for the detail design of Blooming Mills, Structural Mills, Hot and Cold Strip Mills and auxiliary plant.

Apply in writing to:- PERSONNEL DEPARTMENT, DAVY AND UNITED ENGINEERING COMPANY LIMITED, PARK IRON WORKS, SHEFFIELD 4.

OA/3282

K 858

TWO MOULD DRAUGHTSMEN required by AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTS. The work entails making working drawings of a wide variety of moulds covering tyres and general rubber goods manufacture. Good opportunity for suitable applicants to establish themselves in permanent situations.—Apply to the CHIEF ENGINEER, with full particulars, age, etc. K 920C

STRUCTURAL STEELWORK DESIGNERS, SENIOR AND JUNIOR, required for work in connection with large and small Generating Stations and Atomic Power Stations. Five-day week, pension scheme, three weeks annual holiday.—Apply in writing quoting reference SAR to MERZ AND McLELLAN, CARLIOL HOUSE, NEWCASTLE-UPON-TYNE, 1. K 882

STRUCTURAL ENGINEER.
Chief Draughtsman for Branch Office in London. Experienced man, fully qualified to take responsibility for design and detail office covering a wide range of steel construction.—Apply, furnishing details of experience and salary required, to MANAGER, TECHNICAL SERVICES, WRIGHT ANDERSON & CO., LTD., GATESHEAD, 8, CO. DURHAM. K 465

SERVO CONTROL DRAUGHTSMEN AND TRAINEES

required for the design of Industrial Electronic and Magnetic Amplifiers for Servo Mechanisms in connection with Electrical Motor Control Gear and associated equipment. Previous experience in this class of work preferred, but not essential. Experienced Draughtsmen on electrical and/or mechanical work are invited to apply.

Draughtsmen are also required for the preparation of wiring diagrams.

Trainees, of not less than S.2, O.N.C. standard or those who are now taking S.2 will be considered for all of the above. The positions are permanent and the work offers excellent opportunities.

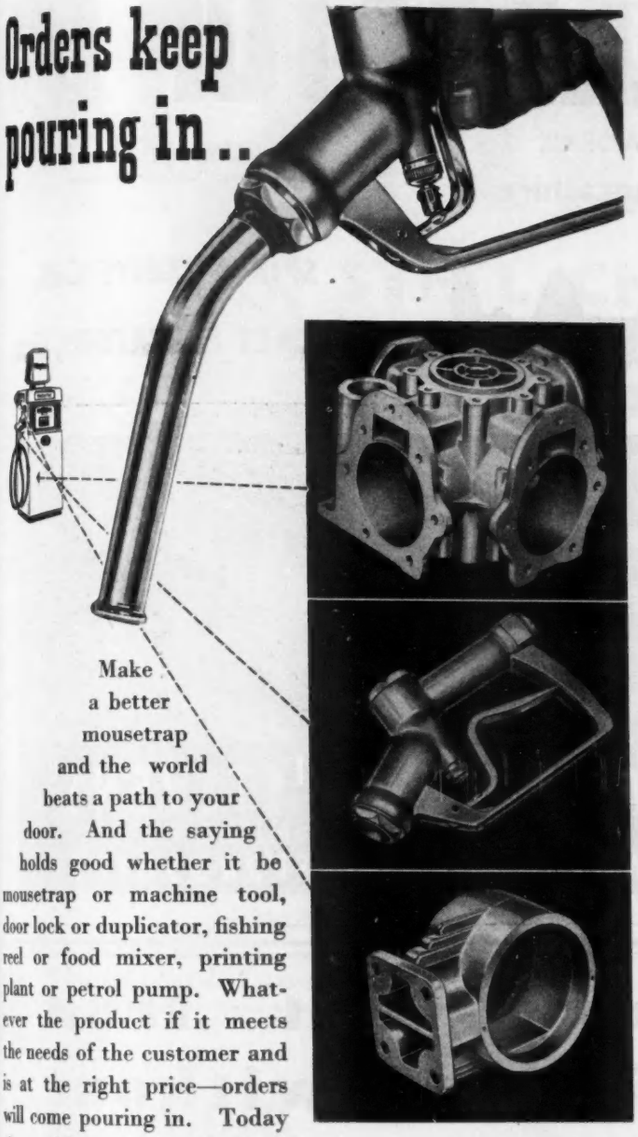
Pension Scheme in operation.

Full canteen facilities.

Apply for application form, quoting reference "T.4," to:—
PERSONNEL MANAGER,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
TRAFFORD PARK, MANCHESTER, 17. K 862

Classified Advertisements continued on Page 91

Orders keep pouring in..



Make a better mousetrap and the world beats a path to your door. And the saying holds good whether it be mousetrap or machine tool, door lock or duplicator, fishing reel or food mixer, printing plant or petrol pump. Whatever the product if it meets the needs of the customer and is at the right price—orders will come pouring in. Today the problem is how to keep pace with demand. Certainly it applies in our case. In order to satisfy demands from new customers we have undertaken a major development programme. The installation of a considerable amount of plant is now complete, enabling us once again to turn our attention to enquiries from new customers.

Wayne Tank and Pump Co. Ltd. are old friends of ours. We illustrate a few of the more recent castings made by us for their latest model.

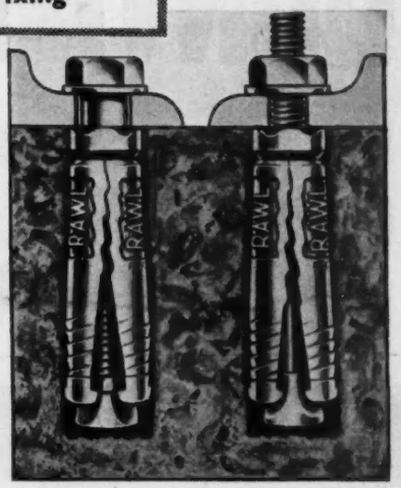
WOLVERHAMPTON DIE CASTING
AFFILIATED WITH PRECISION CASTINGS CO. INC. (U.S.A.)

THE WOLVERHAMPTON DIE CASTING COMPANY LTD.

GRAISELEY HILL WORKS, WOLVERHAMPTON

Telephone: 23831/6

RAWLBOLTS
are a Dry Fixing



With Rawlbolts there is no grouting, no waiting for cement to harden before the equipment can be used. This is an enormous time-saving factor in these days of man-power shortage. The solid sides of a small hole, into which a Rawlbolt fits snugly, afford all the resistance required for the expanding metal shields as the bolt is being tightened. When fully expanded, the metal shields exert a tremendous grip on the sides of the hole, ensuring an absolutely firm fixing.
Rawlbolts are made in all sizes from ⅜in. to 1in. bolt diameter, Whitworth thread. There are two types, Bolt-projecting and Loose-bolt. The latter is specially useful for heavy equipment because bolts can be inserted after the fixture has been placed in position.

If you have a fixing problem, write to our Technical Service Department. They will be delighted to help you.

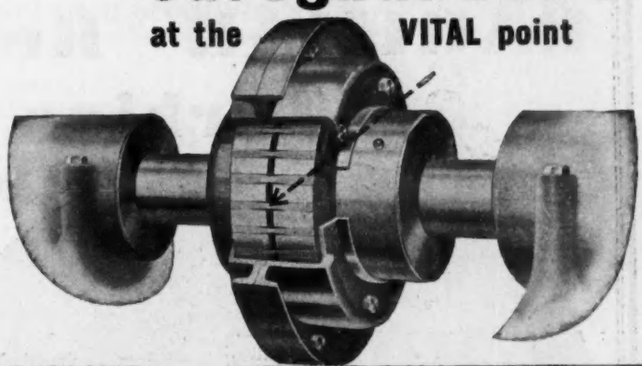
RAWLBOLTS GRIP *by* EXPANSION

Rawlplugs, Rawltools, Rawlbolts, Rawltamps, Rawlnuts, Bolt Anchors, Screw Anchors, White Bronze Plugs, Rawltoggles, Rawlclips, Cement in Sockets, Durium Drills and Hole Boring Tools for Hand, Electric Hammer or Pneumatic Hammer operation.

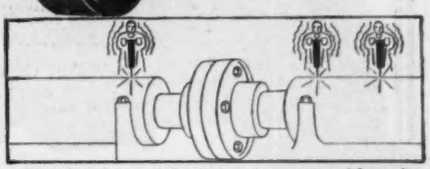
THE RAWLPLUG COMPANY LTD. RAWLPLUGS CROMWELL ROAD, LONDON, S.W.7

B470A

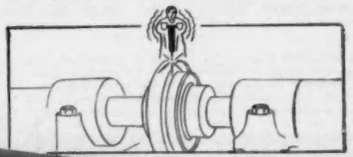
safeguarded!
at the VITAL point



THE VITAL POINT in any power plant is where the shaft of the driving unit links up with the shaft of the unit driven. Vibration, shocks and stresses resulting from misalignment at this point are reflected in loss of power and, eventually, by serious breakdowns.
You can safeguard your plant by fitting Steel-Shaw flexible couplings between units.
Steel-Shaw couplings counter misalignment, absorb vibration, and assure cheaper running and better performances.



Unless checked, accumulative shocks and stresses passed from unit to unit will result in rapid deterioration of plant.



A Steel-Shaw Flexible Coupling absorbs shocks, reduces vibration, and smooths out irregularities of load and power between units.

The STEEL-SHAW *Flexible Coupling*

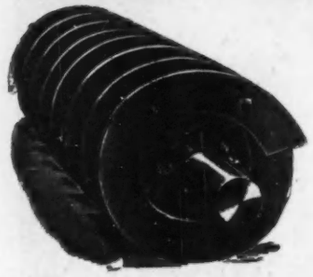
Write now for illustrated brochure No.1227

STEELE & COWLISHAW LTD., Dept. 17, COOPER ST, HANLEY, STOKE-ON-TRENT.

SCL3250

C

CONVEYOR AND ELEVATOR Co (1936) LTD.



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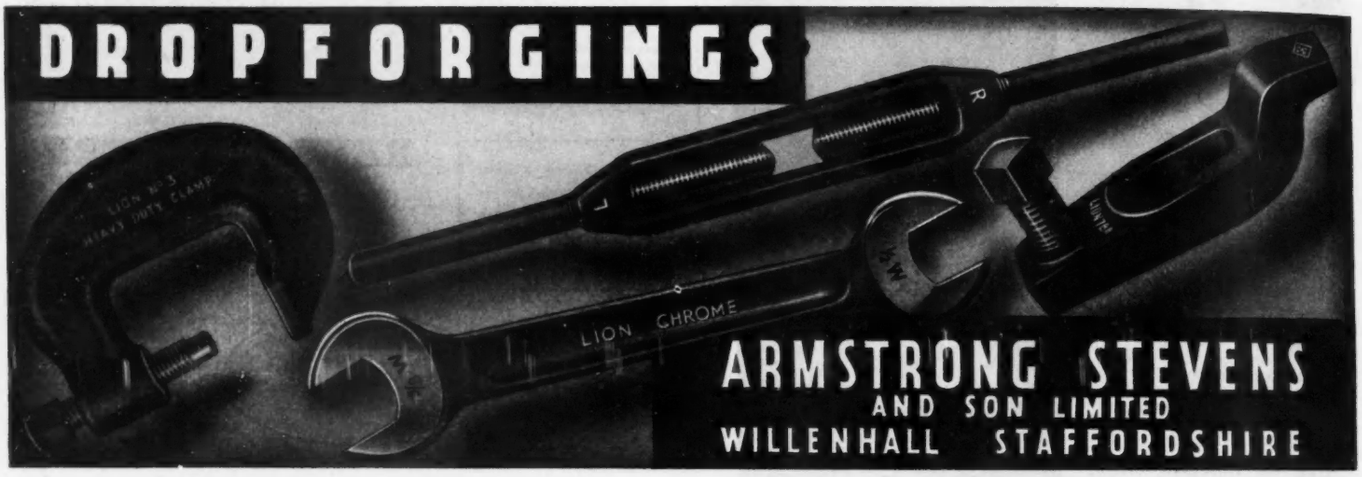

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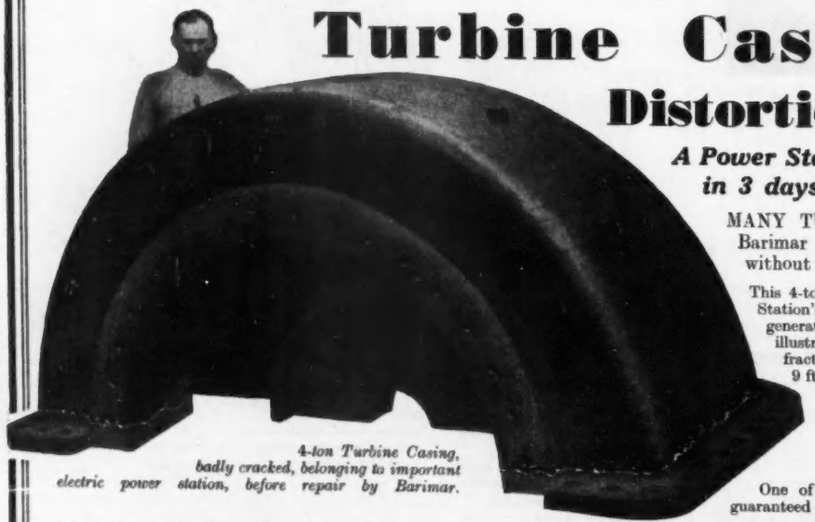

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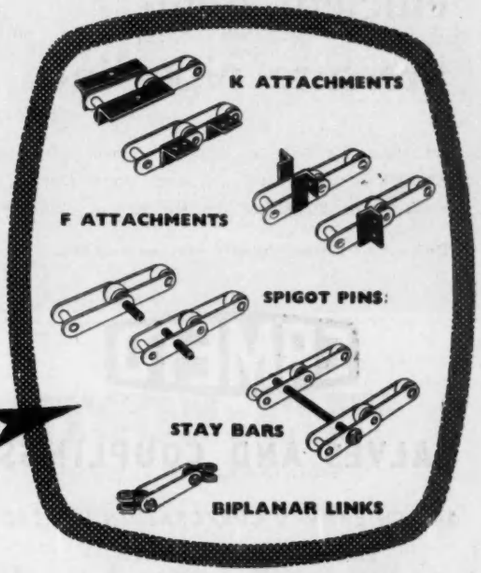

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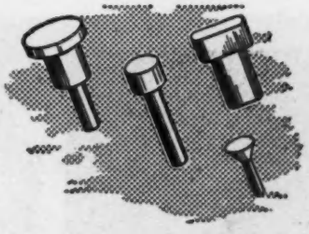

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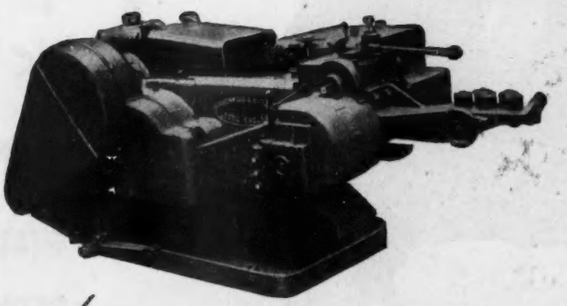

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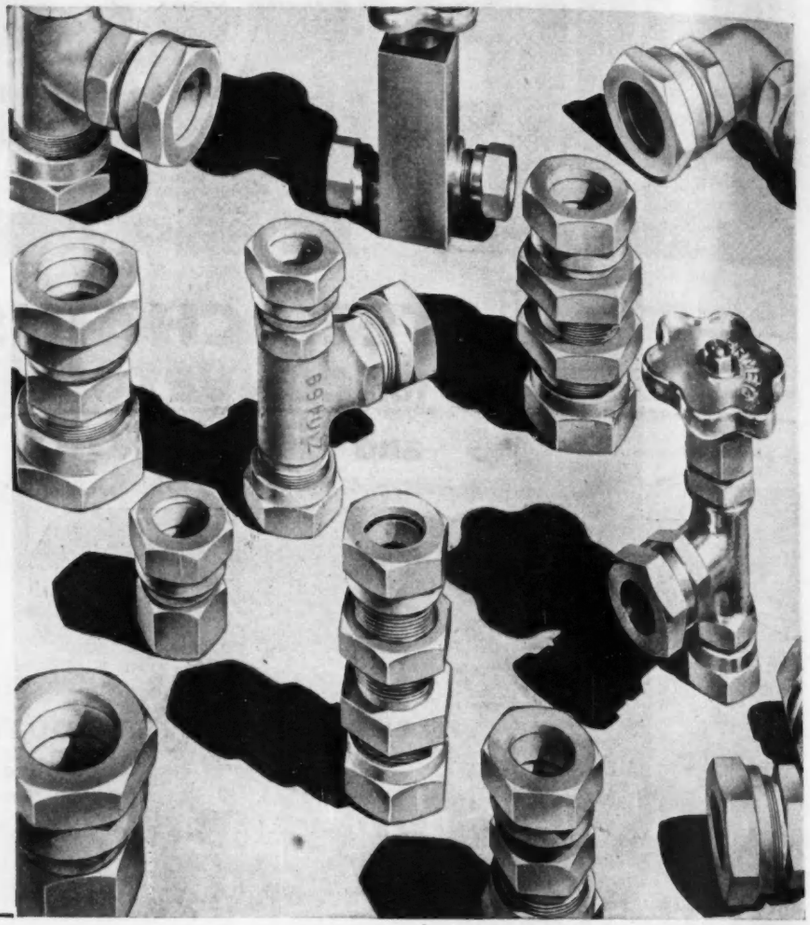

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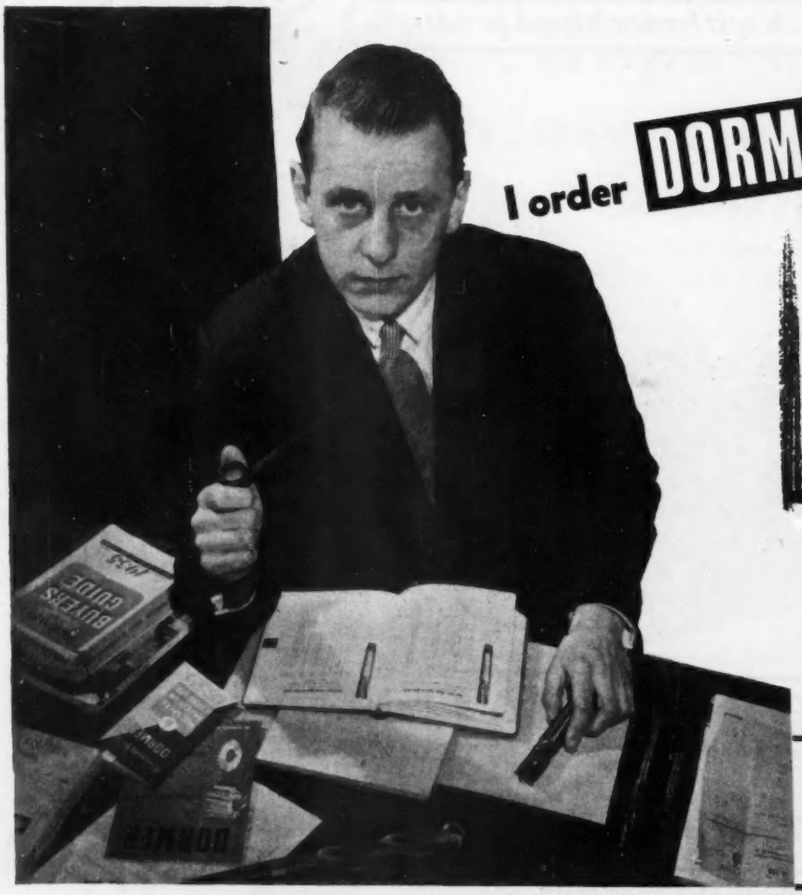

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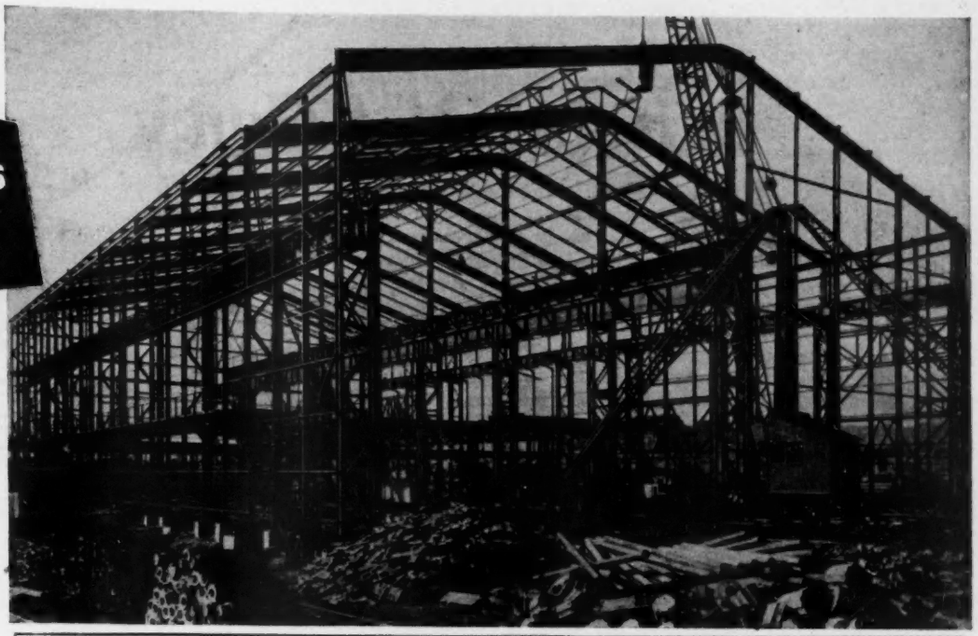

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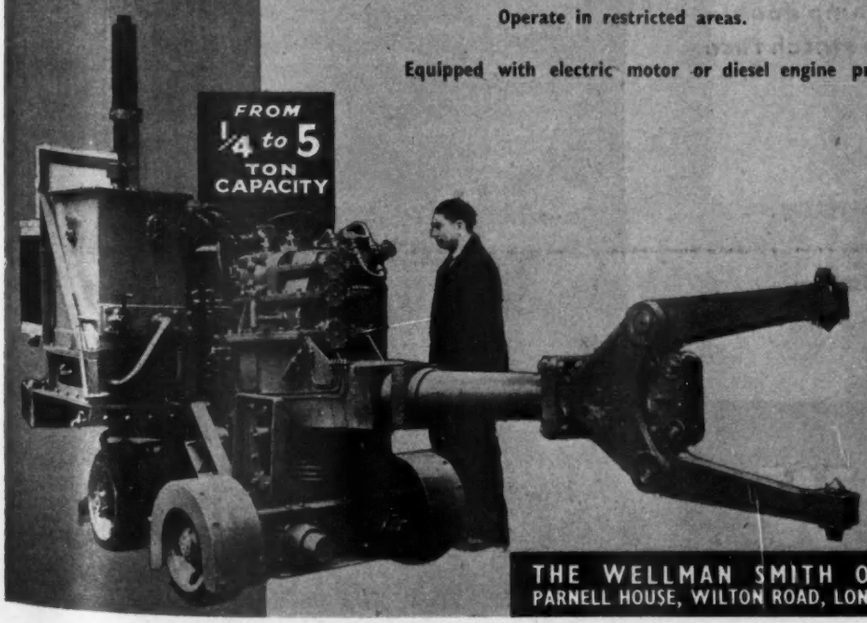

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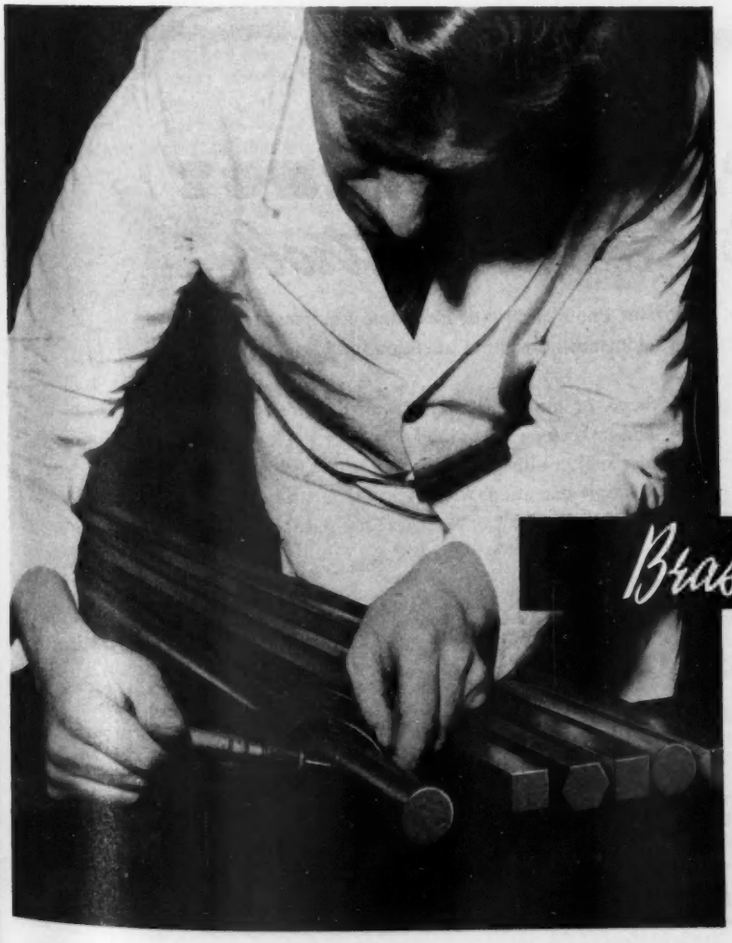

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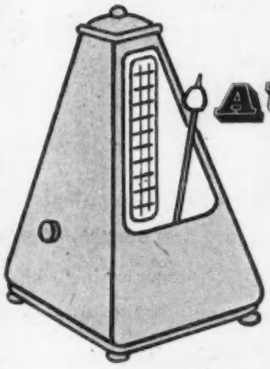

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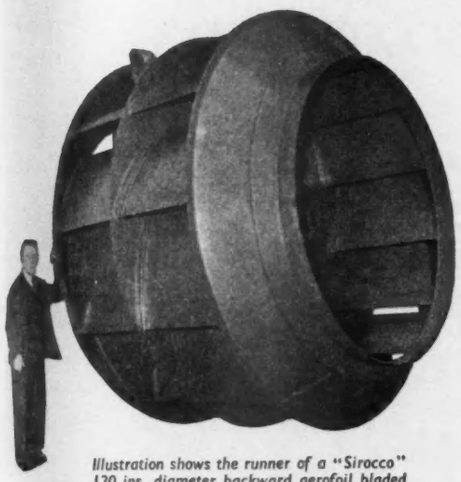

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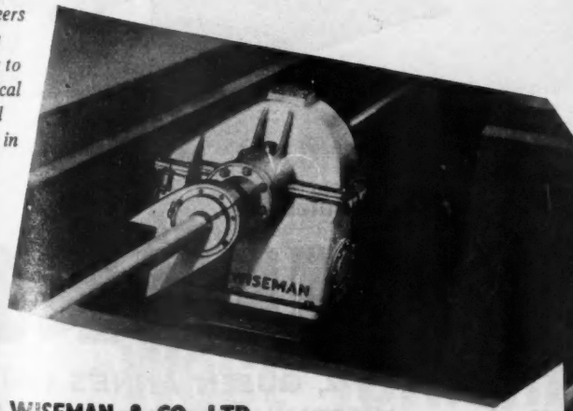

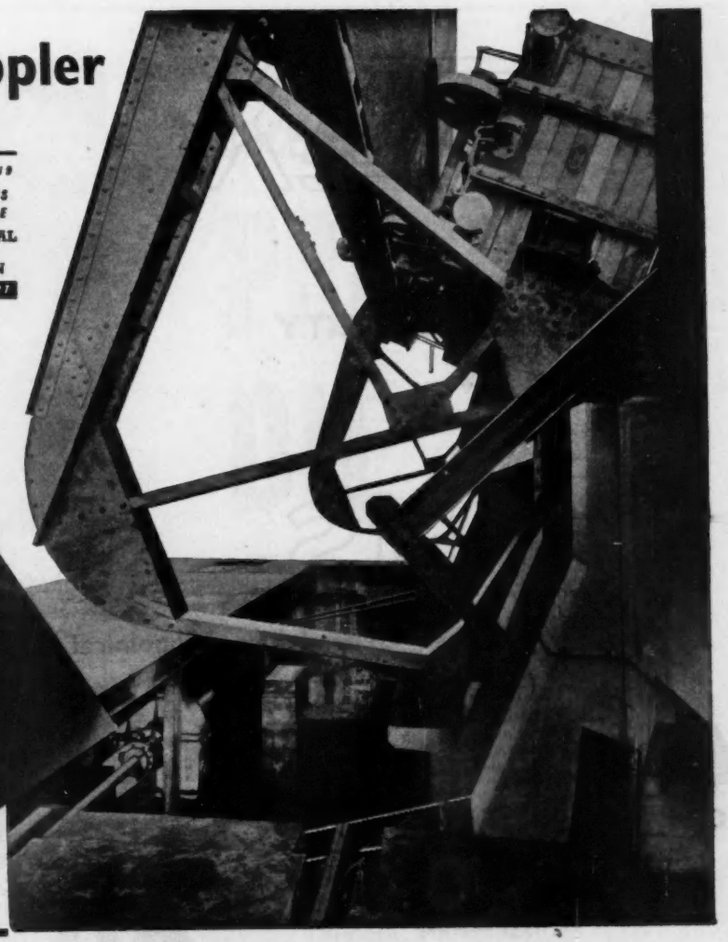

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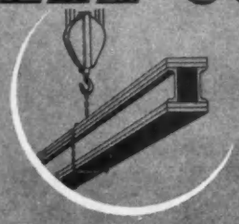

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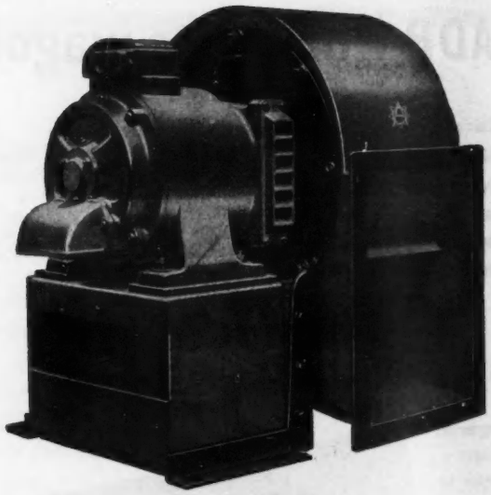

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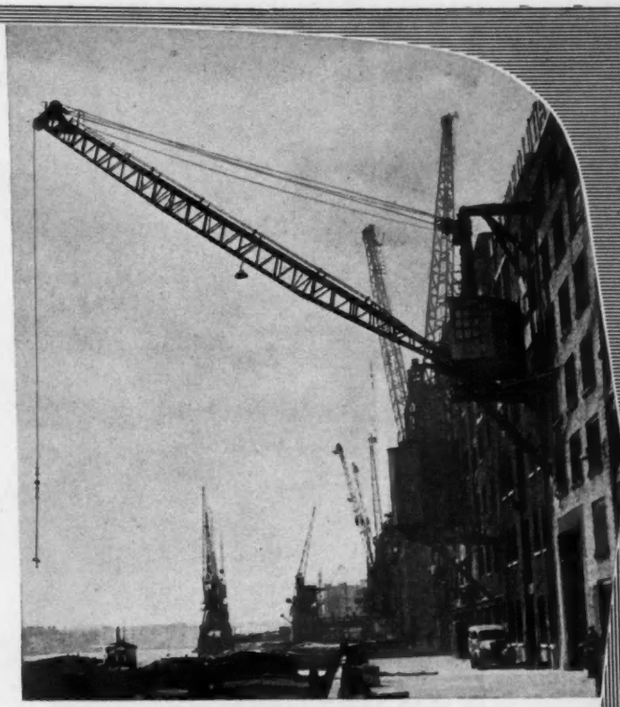

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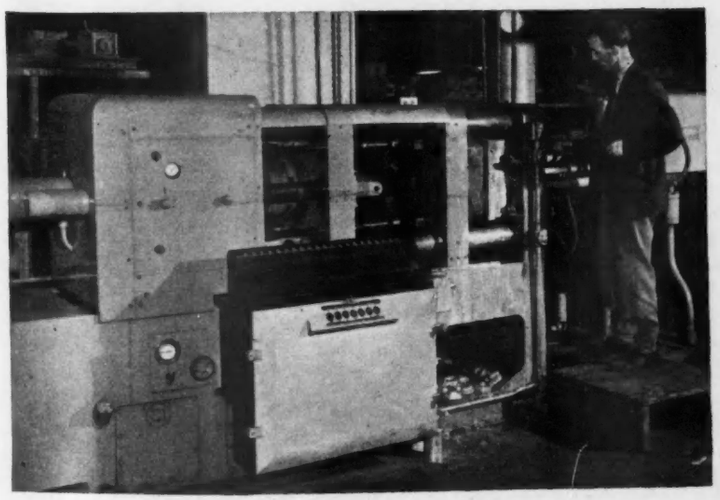

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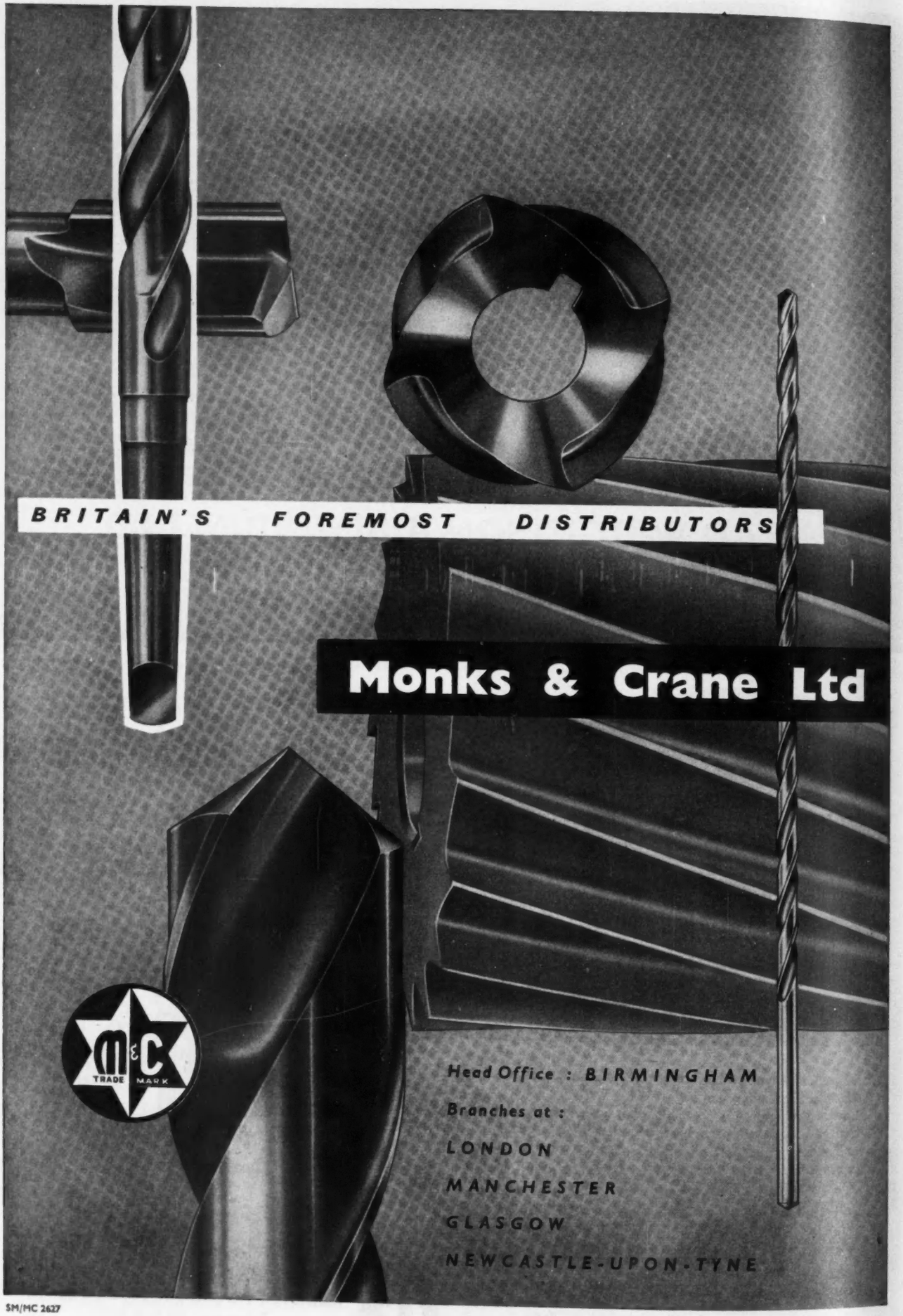
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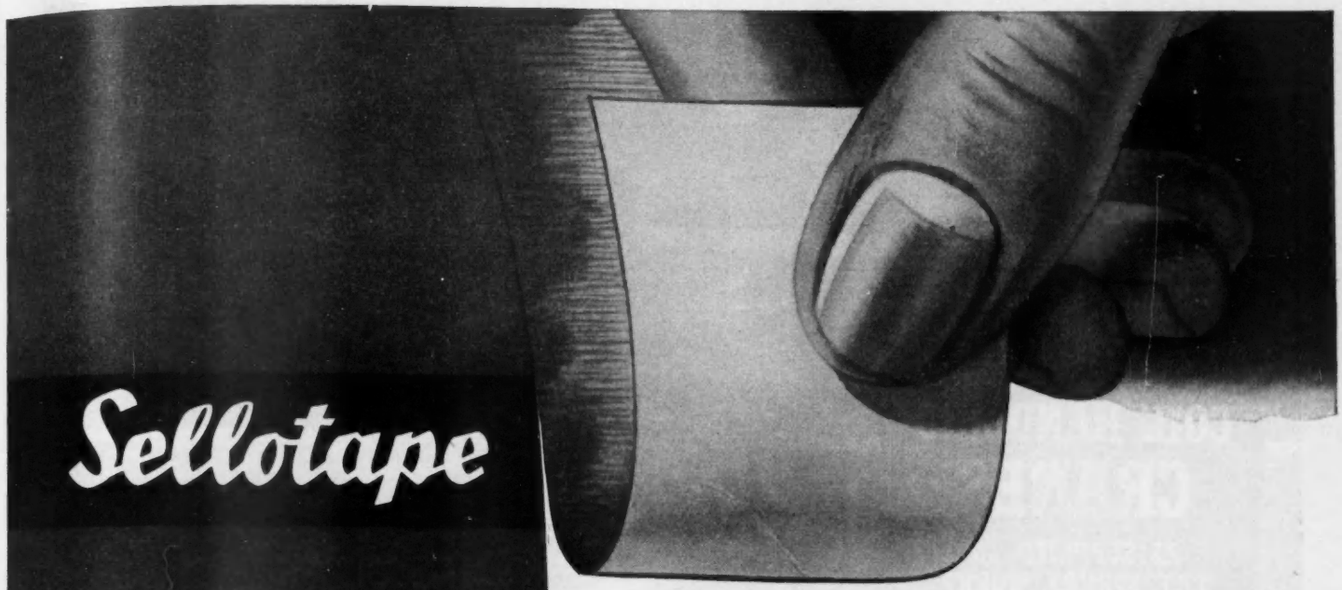

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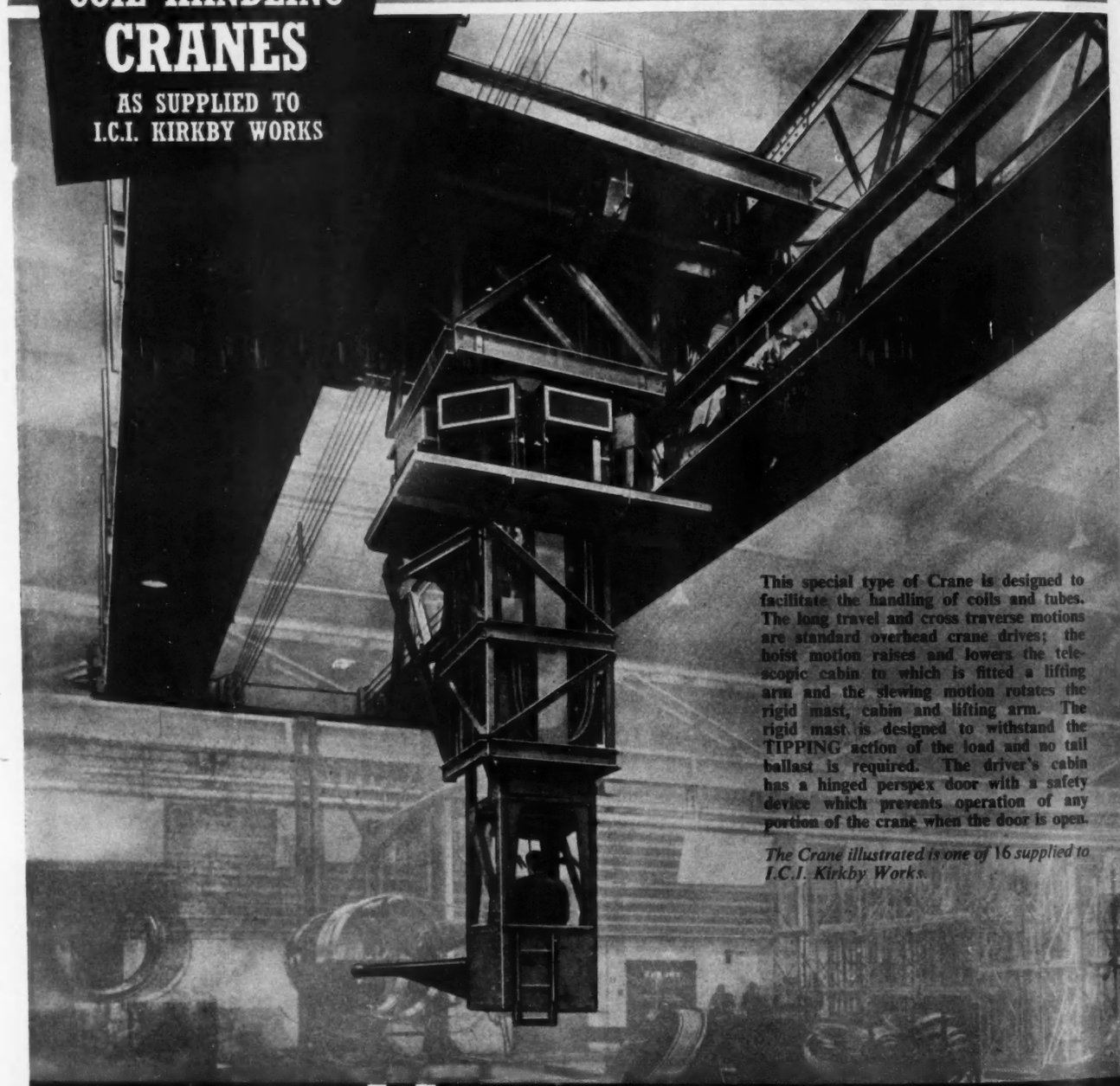

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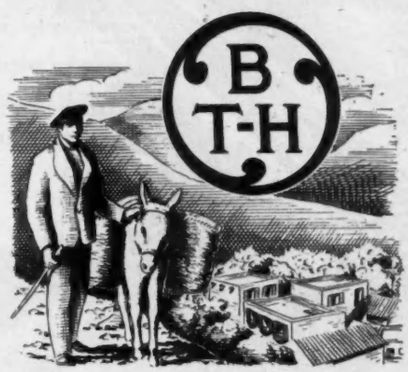
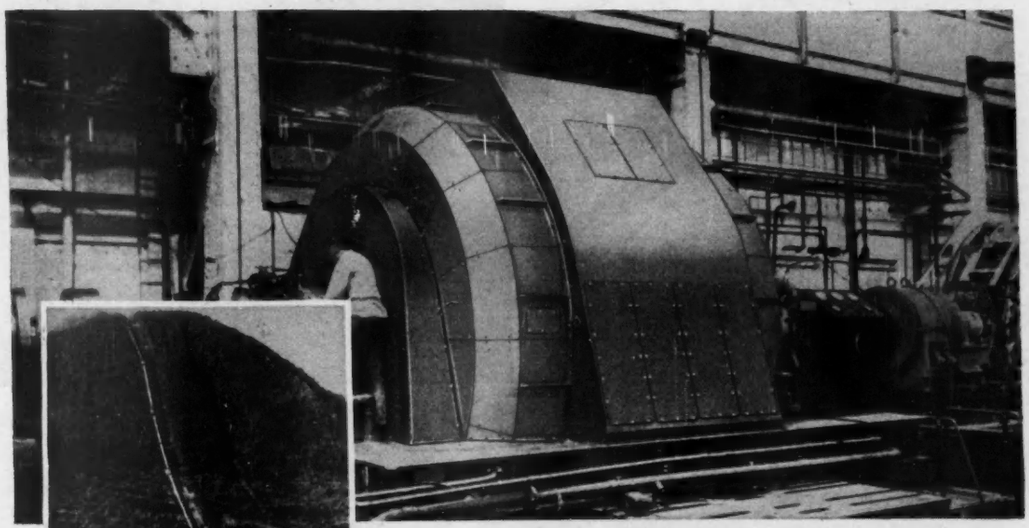
Many of the rivers of Spain and France rise in the High Pyrenees. Their waters are harnessed to supply electric power for railways, for industry and for the domestic supply of the surrounding countryside. Here, at Artias, where the River Garonne leaves Spain for its long flow through France, Sociedad Productora de Fuerzas Motrices, S.A. have built a new power station. It is 3,700 ft. above sea level, and in it BTH equipment is once again used to help harness the power of natural resources.





One of the two BTH generators on test at Rugby Works.

Two 42,500-kVA, 600-r.p.m., 11-kV generators have been supplied by BTH, each driven by two single-jet Pelton turbines supplied by Ets Neyrpic, Grenoble, one wheel being overhung from each end of the generator shaft. These turbines operate under a head of 2,600 ft.

General view of the power station and the penstock.

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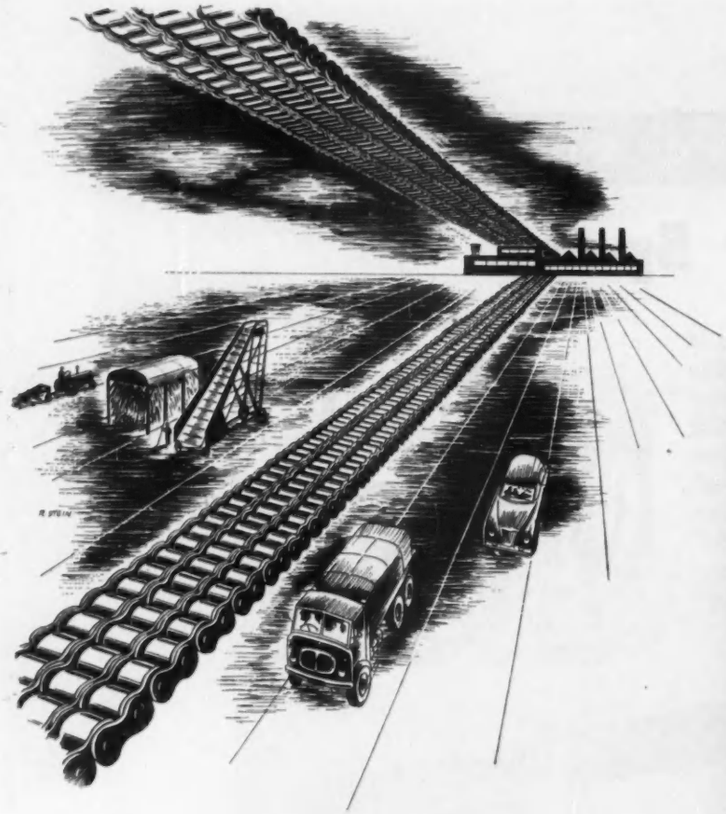
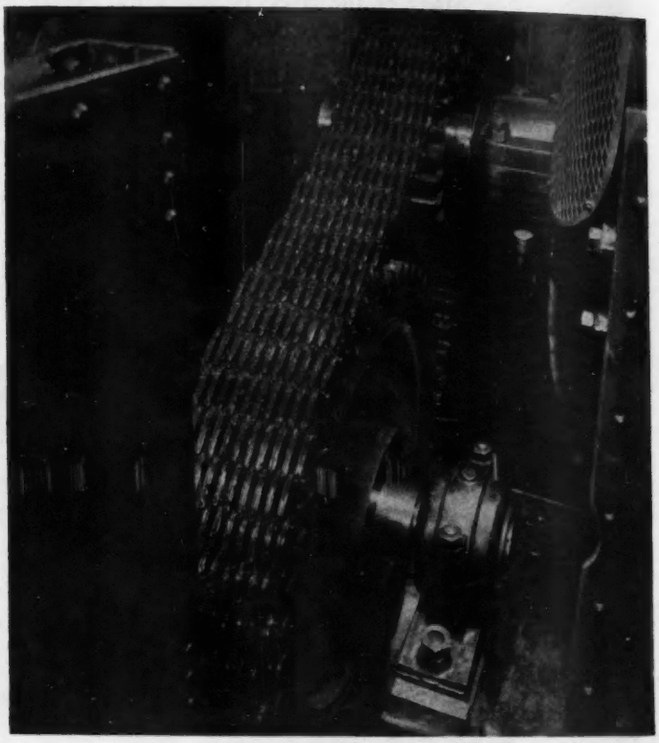


In the long run it pays to install MORSE chains



Picture by courtesy of Southern Region B.T.C.

In 1912 a Morse 70 h.p. Inverted Tooth Type 2in. pitch 7in. wide Chain drive was installed at the Brighton Depot of the London, Brighton and South Coast Railway to drive a deep well pump. This drive has been in constant use since that time and is still giving the same trouble-free service as it did in 1912.

CONSTANT research, long experience, the highest standards of manufacture and inspection ensure that Morse Chains give the trouble-free service with a minimum of maintenance which is essential to the efficient and economic running of industrial plant. For over fifty years, engineers have been specifying Morse Chains with the knowledge that, although designs may change, the built-in quality never varies.

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Symbolizing the revelation to mankind of atomic energy as a transcending power for good, Eric Fraser's mural is a reminder of our responsibility in a world that is overshadowed by its power for evil.

The omens are favourable. The first International Conference on the Peaceful Uses of Atomic Energy, at Geneva, which focussed world attention on an unprecedented gathering of atomic physicists and engineers, revealed the startlingly parallel progress that had been made by the 'atomic' nations, working independently.

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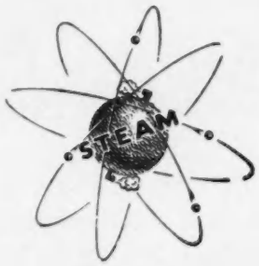
A notable feature of this progress is the universal adoption of STEAM *as the only practical medium, in the foreseeable future, for the conversion of atomic to electrical power.*

Babcock & Wilcox Ltd., as the world's leading steam engineers, with the experience of many years' close collaboration with the Atomic Energy Authority, are making an outstanding contribution to atomic progress with the manufacture of specialized steam-raising plant for the world's first atomic power stations—a major step towards the realization of a great ideal.



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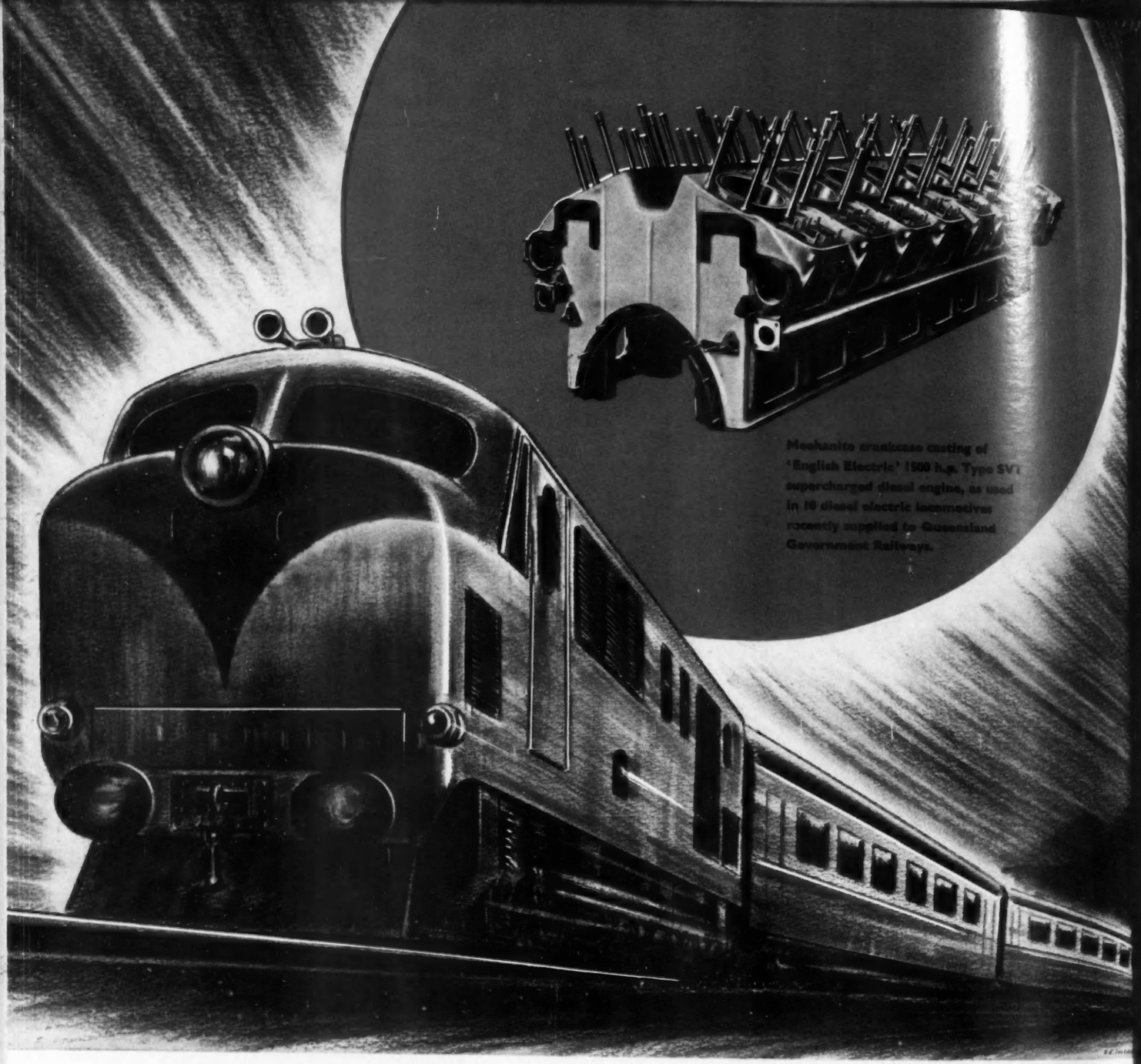

Meehanite crankcase casting of 'English Electric' 1500 h.p. Type SVT supercharged diesel engine, as used in 10 diesel electric locomotives recently supplied to Queensland Government Railways.

Why 'ENGLISH ELECTRIC' use MEEHANITE castings for their traction diesels

"The bedplates, crankcases and cylinder heads of 'English Electric' Type SVT diesel engines are all Meehanite castings. These, although subjected to the exceptional stresses of rail traction duty, must be essentially lightweight and yet possess physical properties better than normally required for ferrous castings. Cylinder heads must withstand pressures of over 900 pounds per square inch and all castings must be of a dense, non-porous nature entirely free from blow-holes."

Many famous engineering firms have found that Meehanite's high strength, coupled with its homogeneous, close-grained texture, permit valuable weight reductions to be made.

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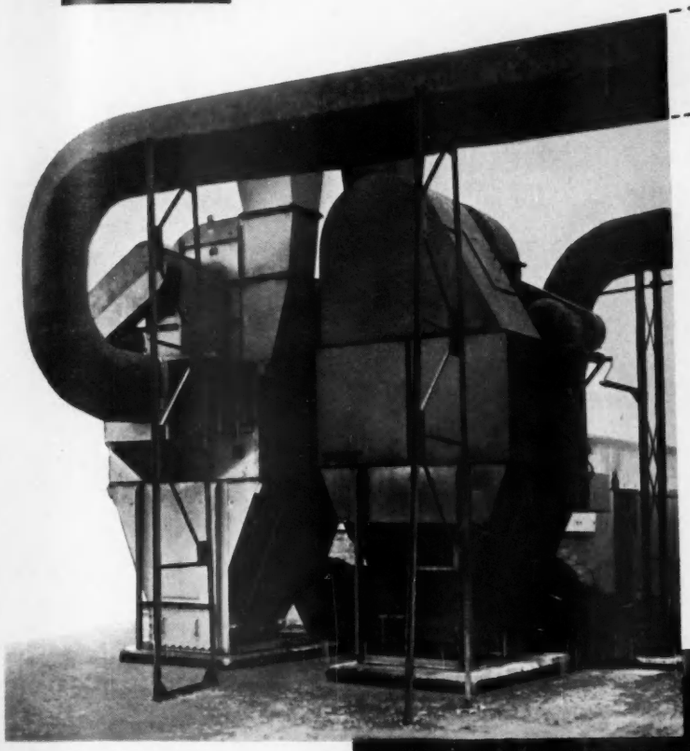

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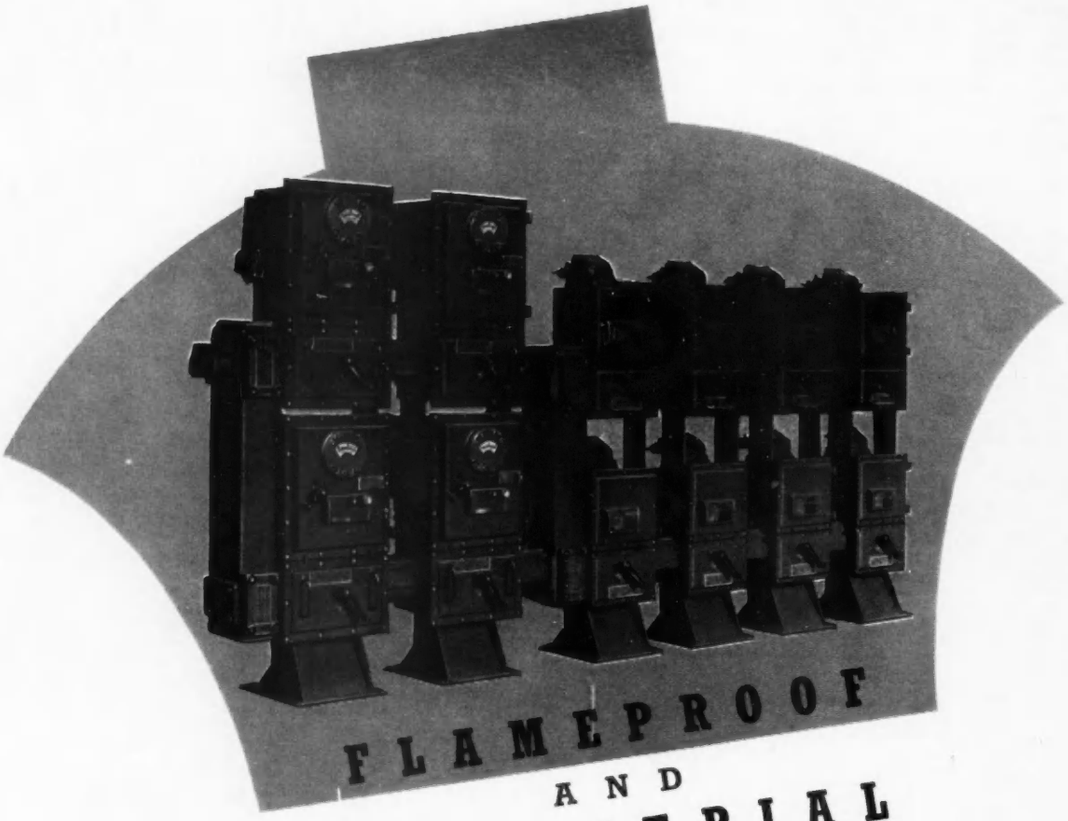

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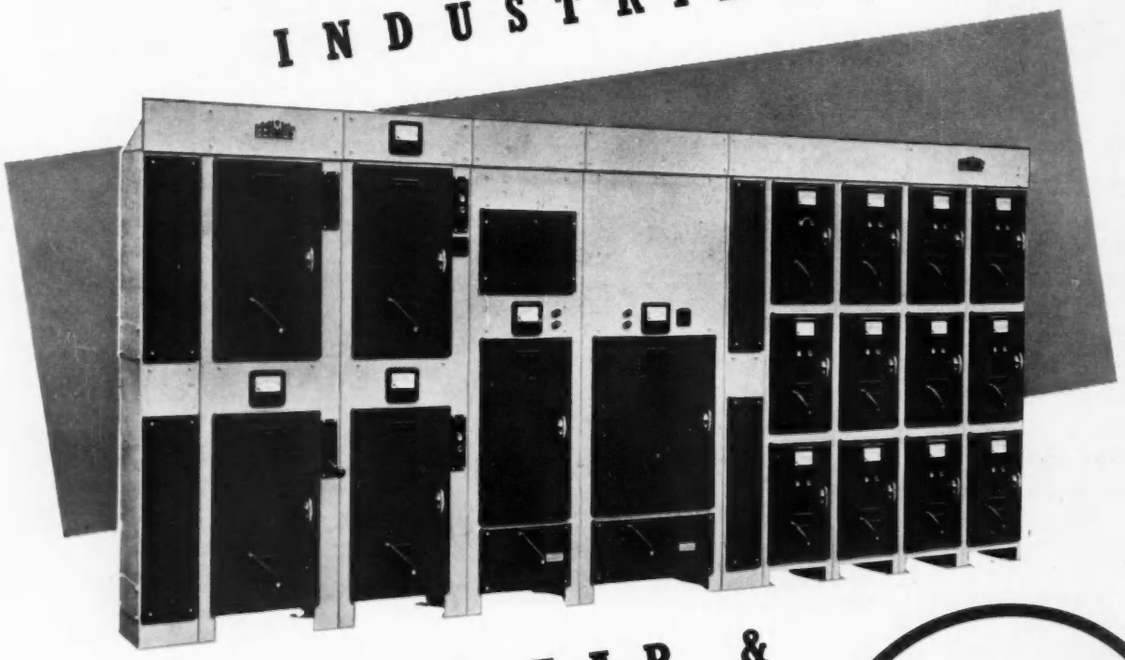

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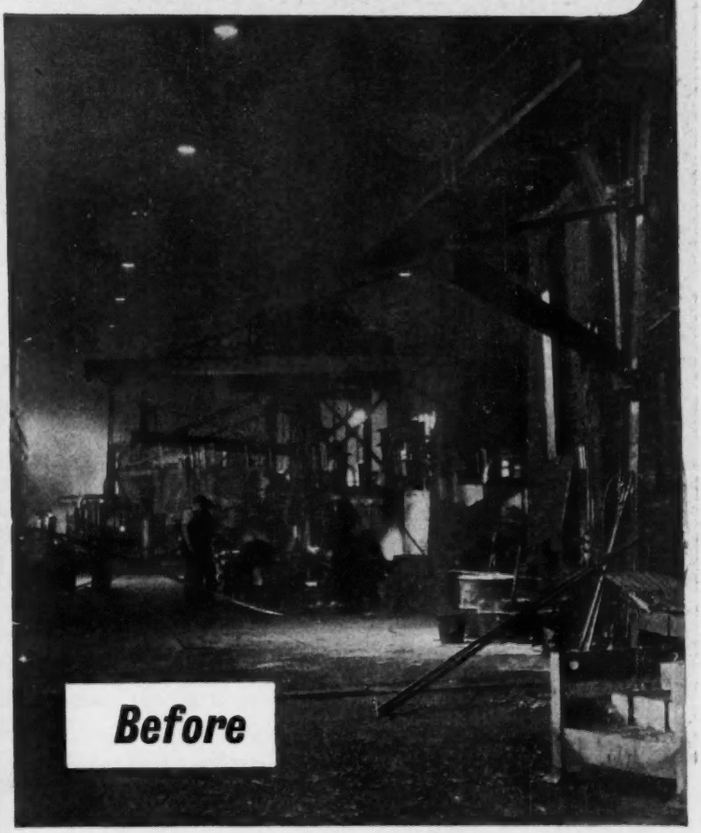

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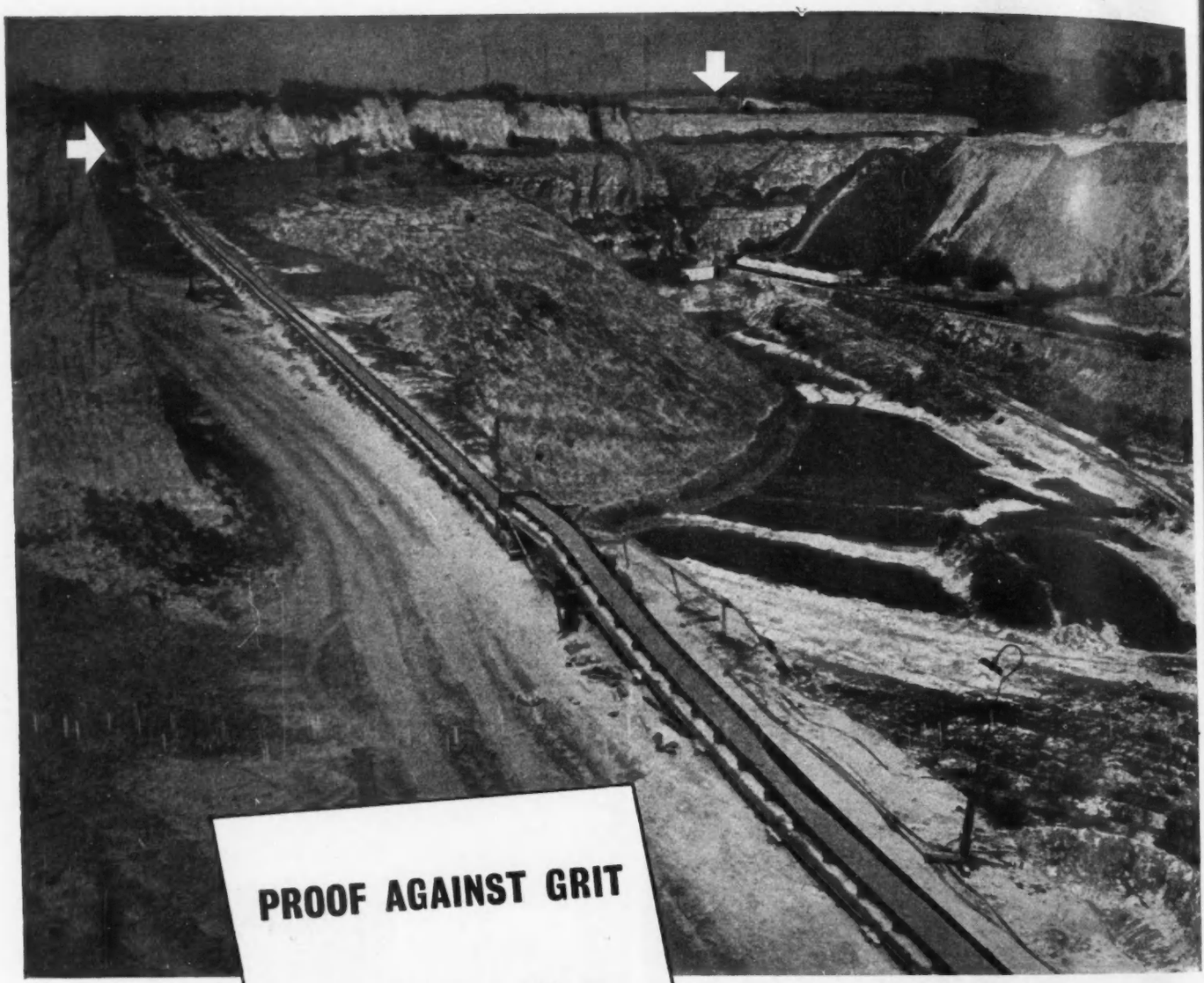

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★ M & C idler rollers ★

The conveyor line passes through the tunnel on the left, and is marked in the distance by the further arrow.

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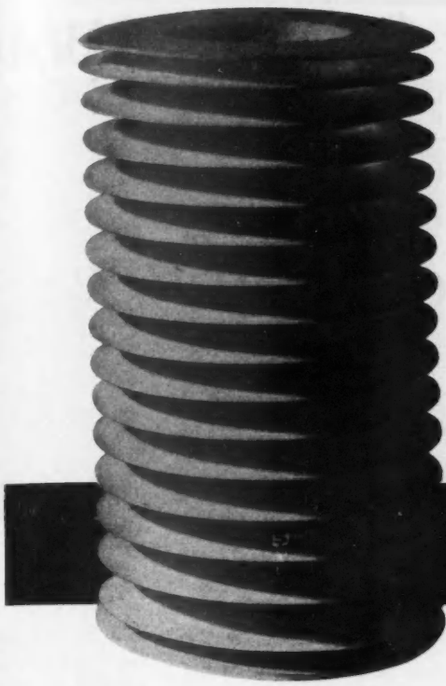

CORROSIVE-RESISTANT PTFE FLEXIBLE BELLOWS

for corrosive fluids

These flexible bellows are the latest PTFE components to be developed by the PTFE Engineering Division of Crane Packing Limited of Slough. They are formed by an exclusive patented process of manufacture which almost halves the amount of material used, and substantially increases the mechanical strength of the bellows, compared with those produced by conventional methods.

The bellows are at present offered in a range of bore sizes from ½in. to 6in. and in corresponding nominal free lengths from 1½in. to 3in. with wall thicknesses ranging from 0·020in. to 0·040in. Corresponding extensions are from 0·6in. to 1·6in.

Initial tests have shown that these bellows will withstand at least 1,000,000 oscillations between the minimum and maximum working lengths at normal temperatures, and at pressures around 100 p.s.i. Tests are continuing at higher temperatures and pressures, and the results will be published in due course.

The properties and characteristics of the basic material are given full expression in these bellows—they are unaffected by contact with all known corrosives and solvents, with the exceptions of molten sodium and fluorine gas.

Engineers wishing to know more about this material, and about the basic and component forms in which it can be supplied, should write to the PTFE Engineering Division of Crane Packing Limited of Slough, for Information Bulletins Nos. 4 and 5; and for special information regarding any particular application in which they are especially interested.

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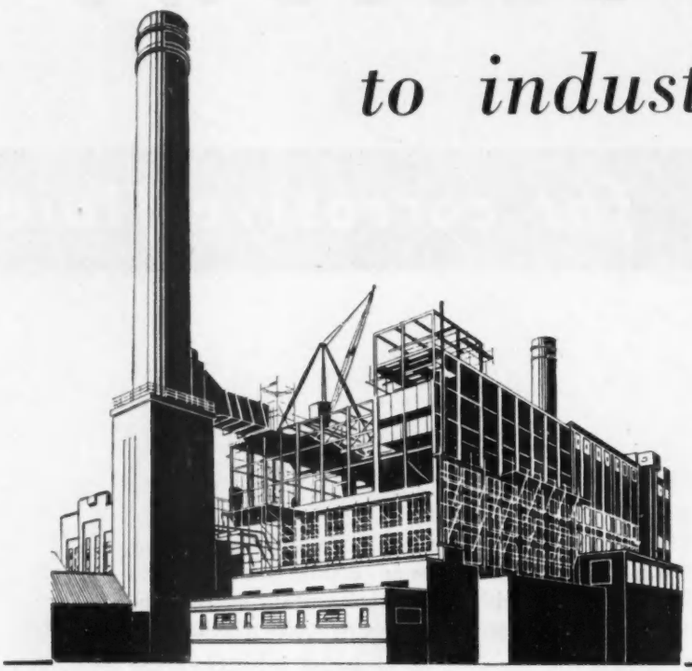

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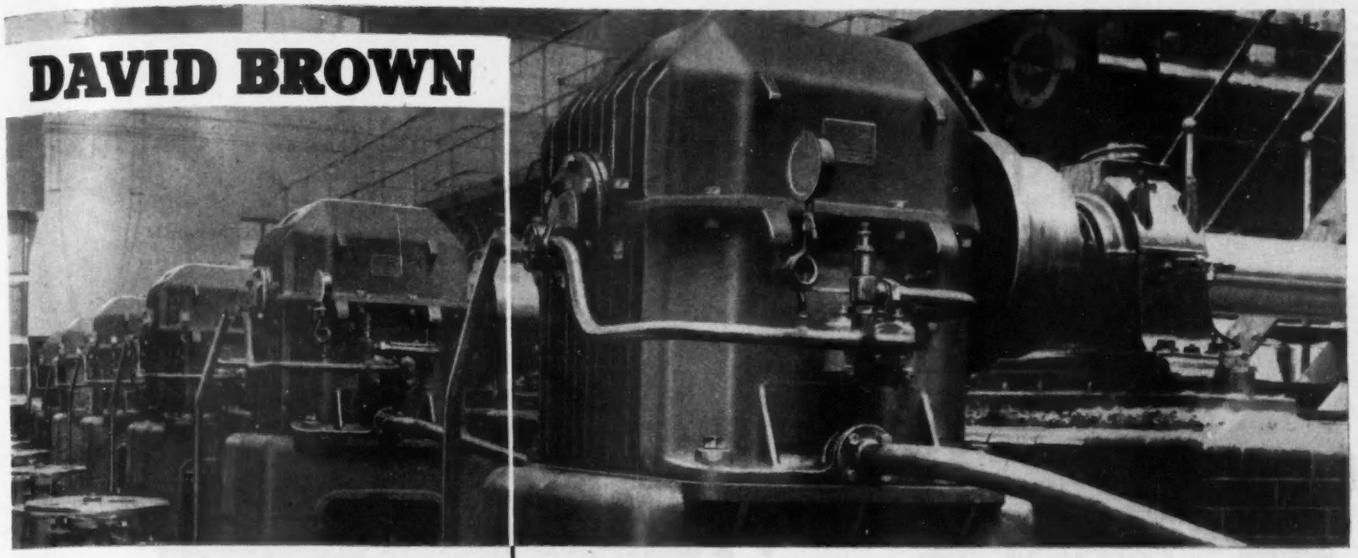

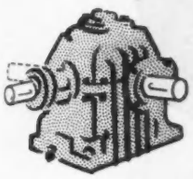

B H
Horizontal High Speed Shaft and Single or Double Ended Horizontal Slow Speed Shaft.

B H V
Horizontal High Speed Shaft and Single or Double Ended Vertical Slow Speed Shaft.

B V H
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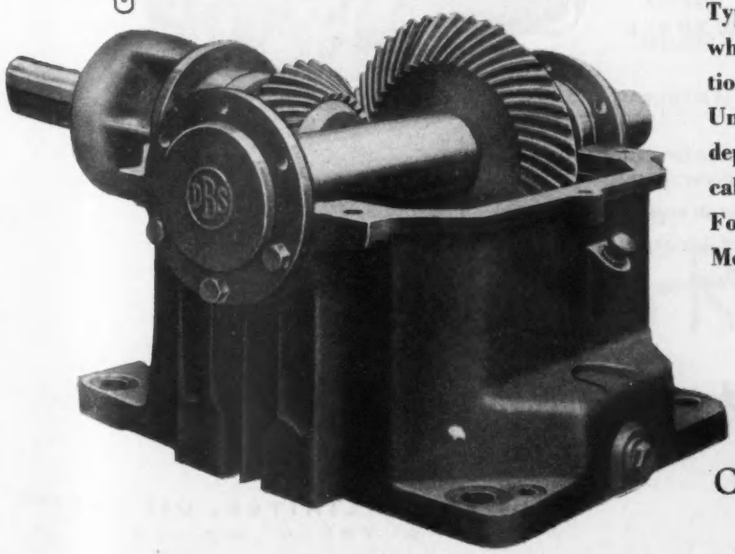

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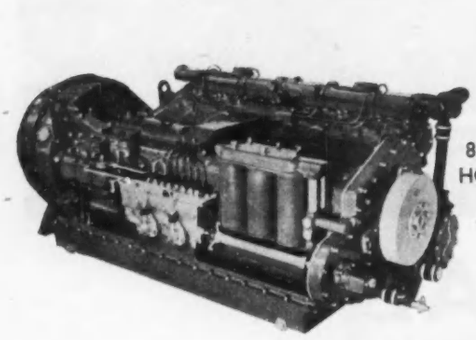
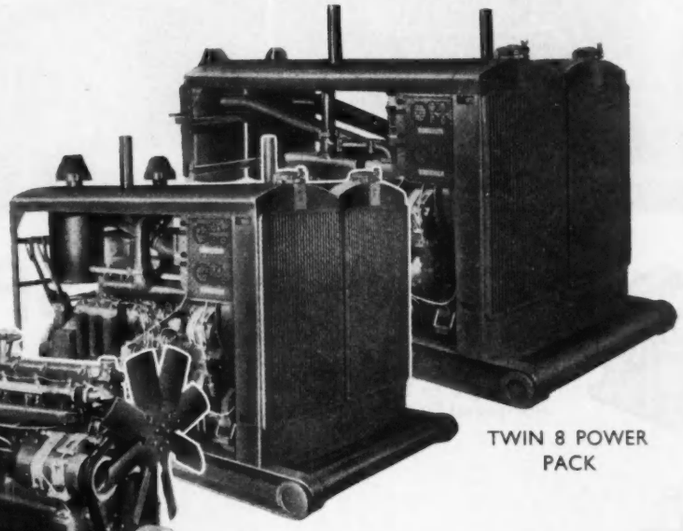
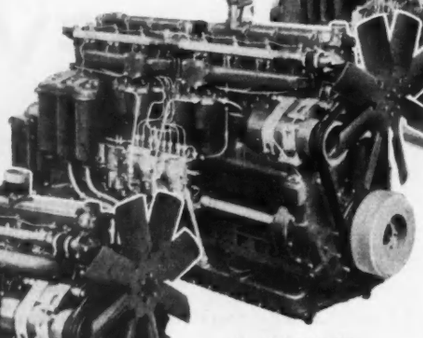


8 CYLINDER
HORIZONTAL

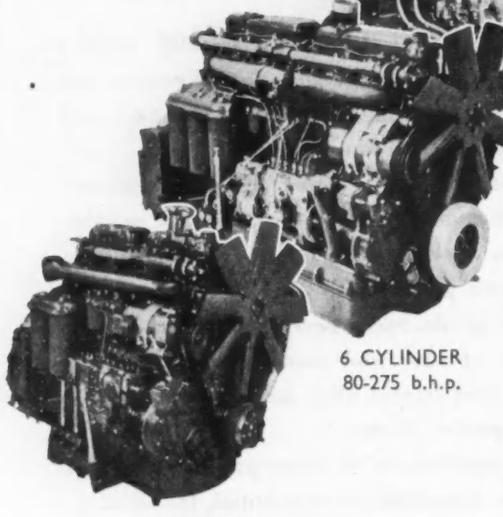


TWIN 8 POWER
PACK

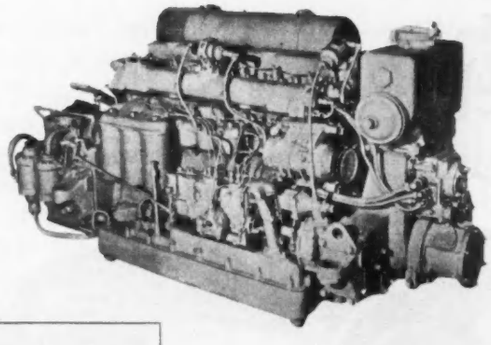


TWIN 6 POWER
PACK

8 CYLINDER
100-300 b.h.p.



6 CYLINDER
80-275 b.h.p.



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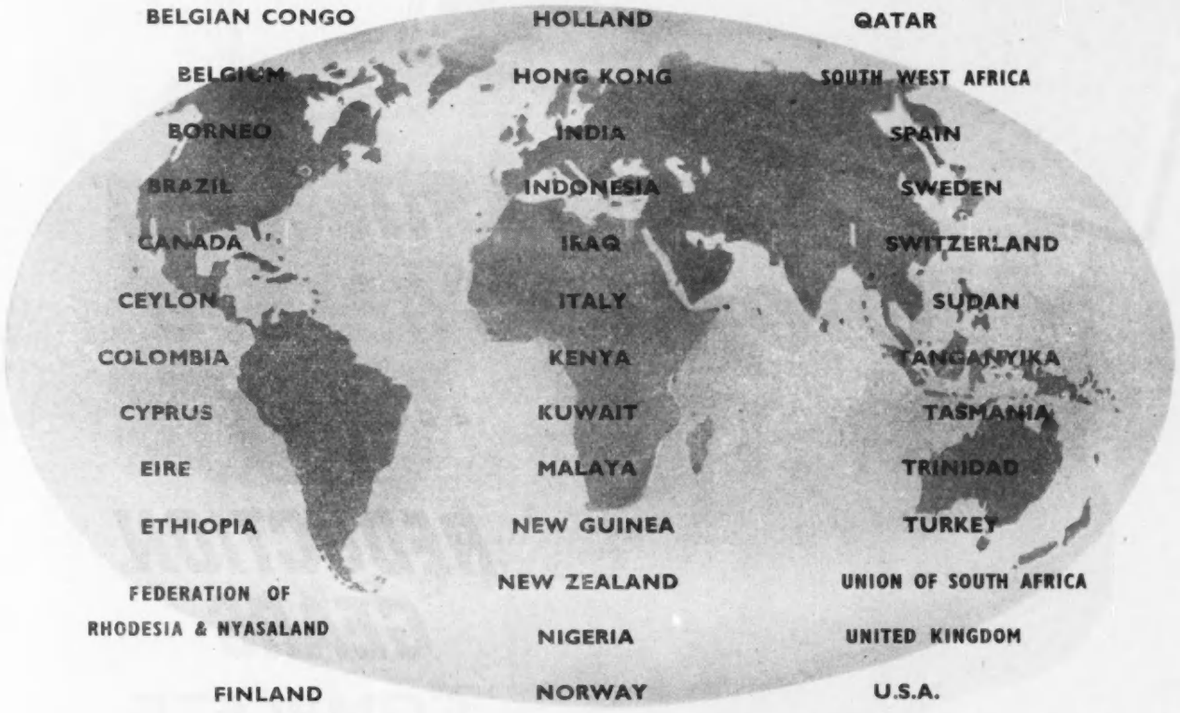

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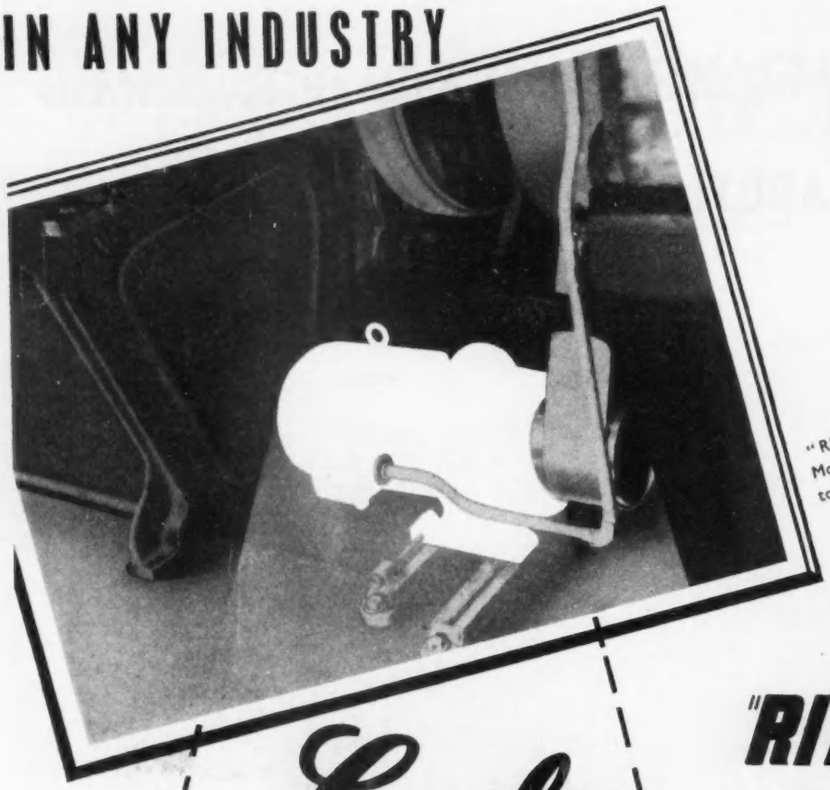

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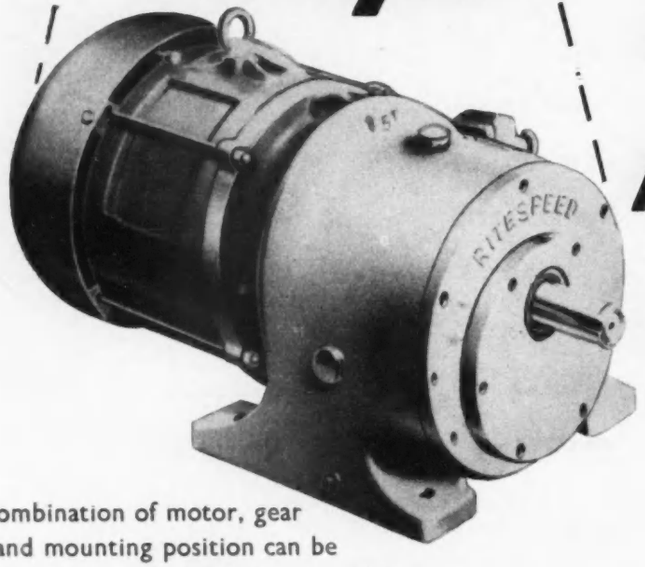

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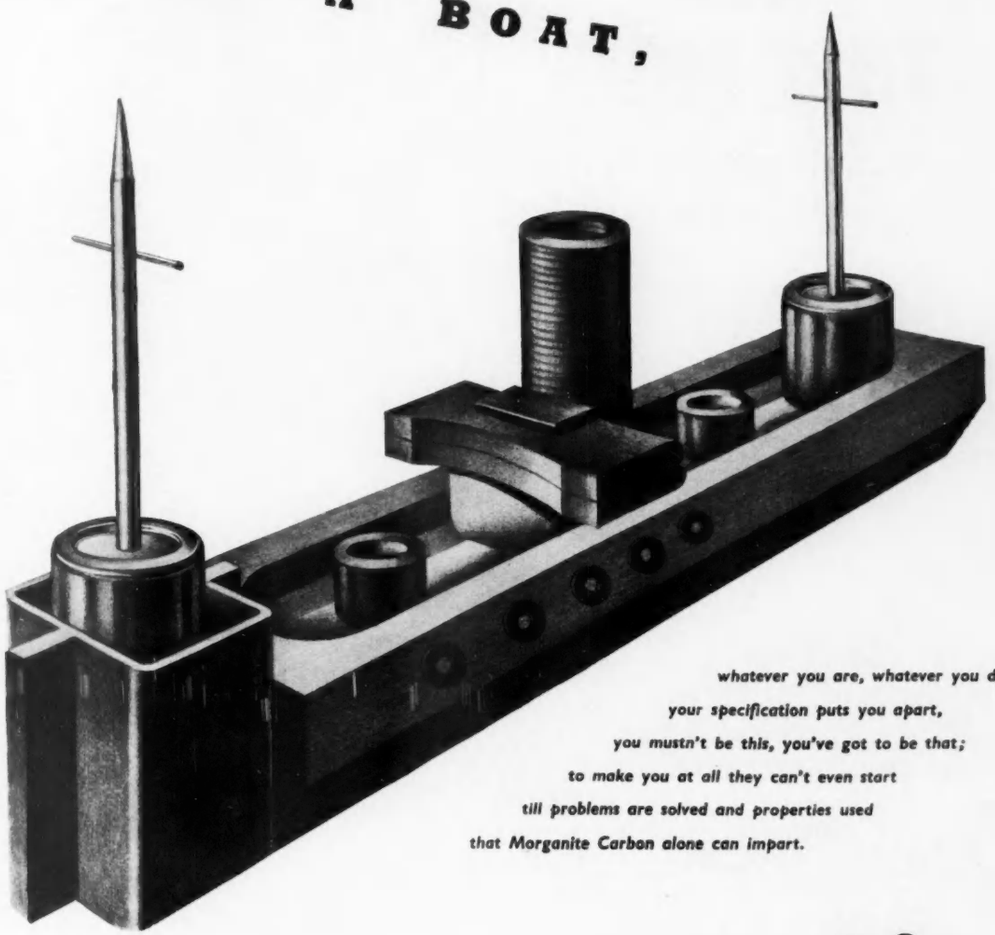

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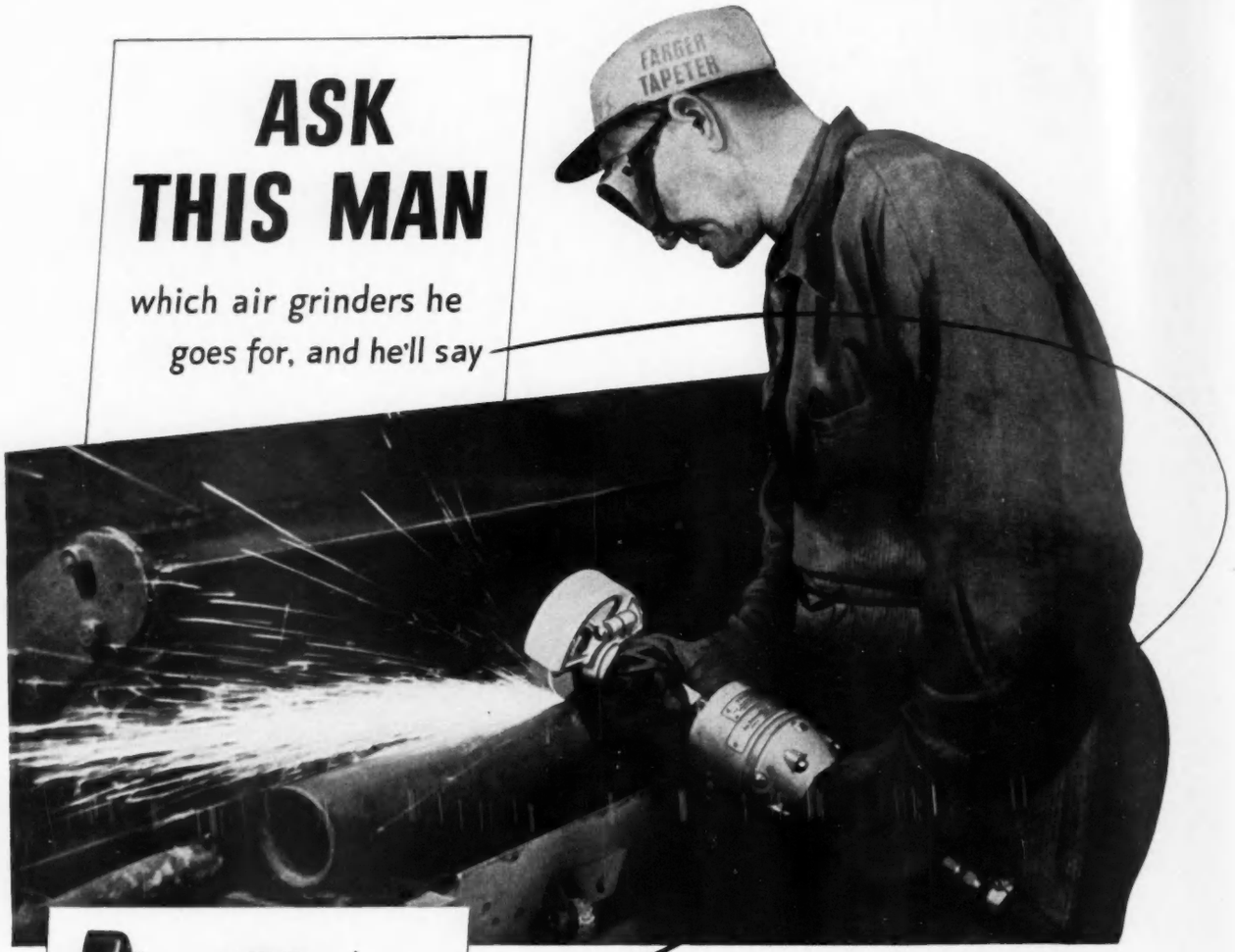
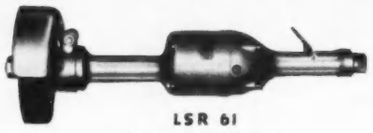
which air grinders he goes for, and he'll say

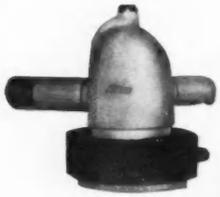




LSR 61
Heavy-Duty Grinder.

LSR 21
High-Speed Grinder.

LSR 11
High-Speed Grinder.



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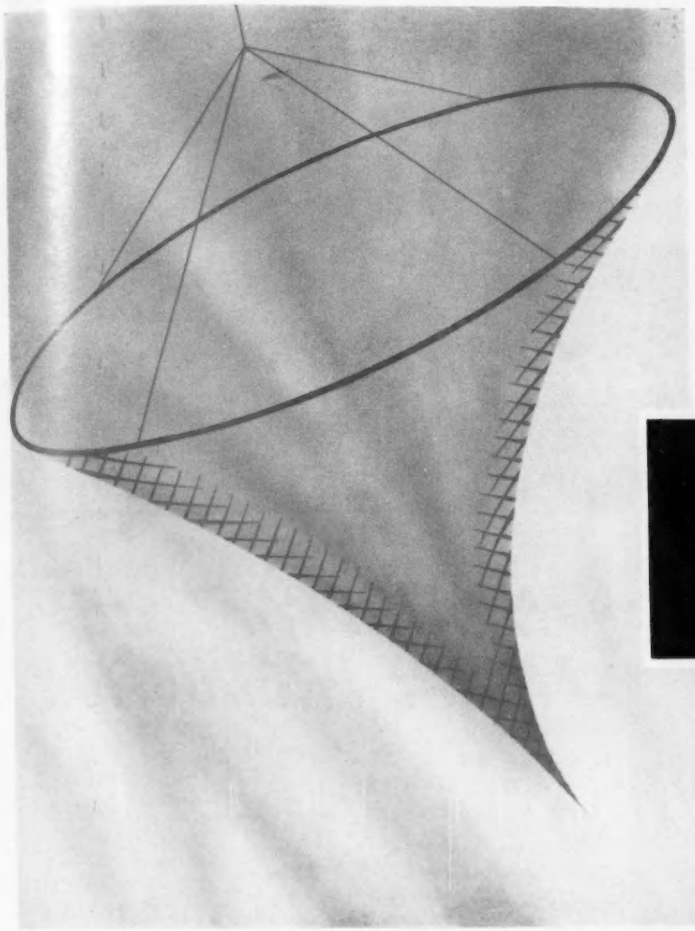

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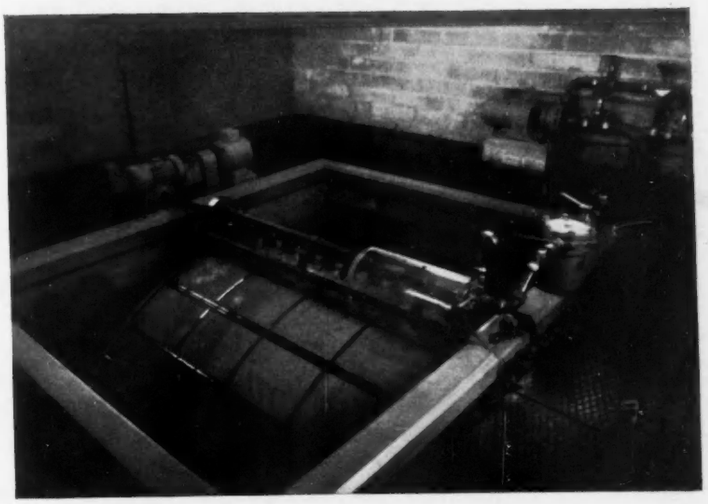

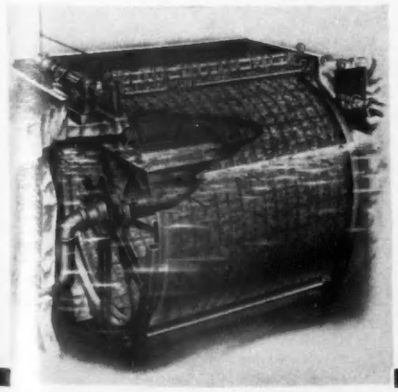

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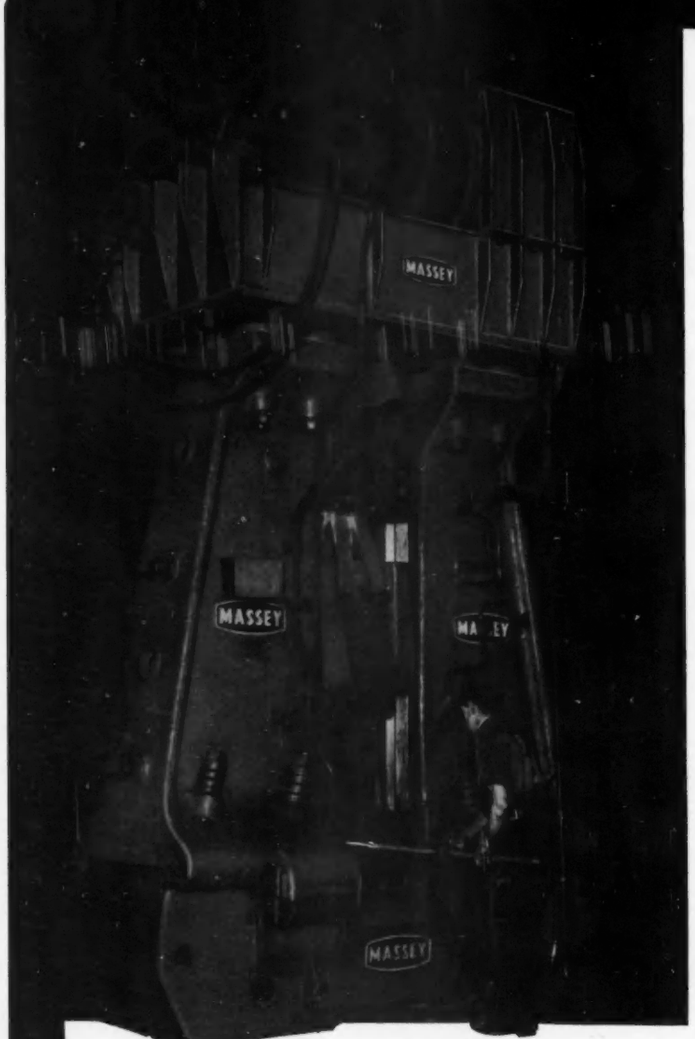

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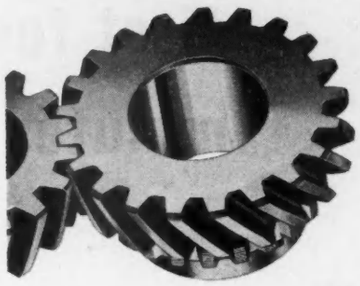

Nagel Horizontal Honing Machine. Capacity from ¼" to 2½" dia. bores.

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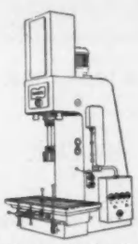

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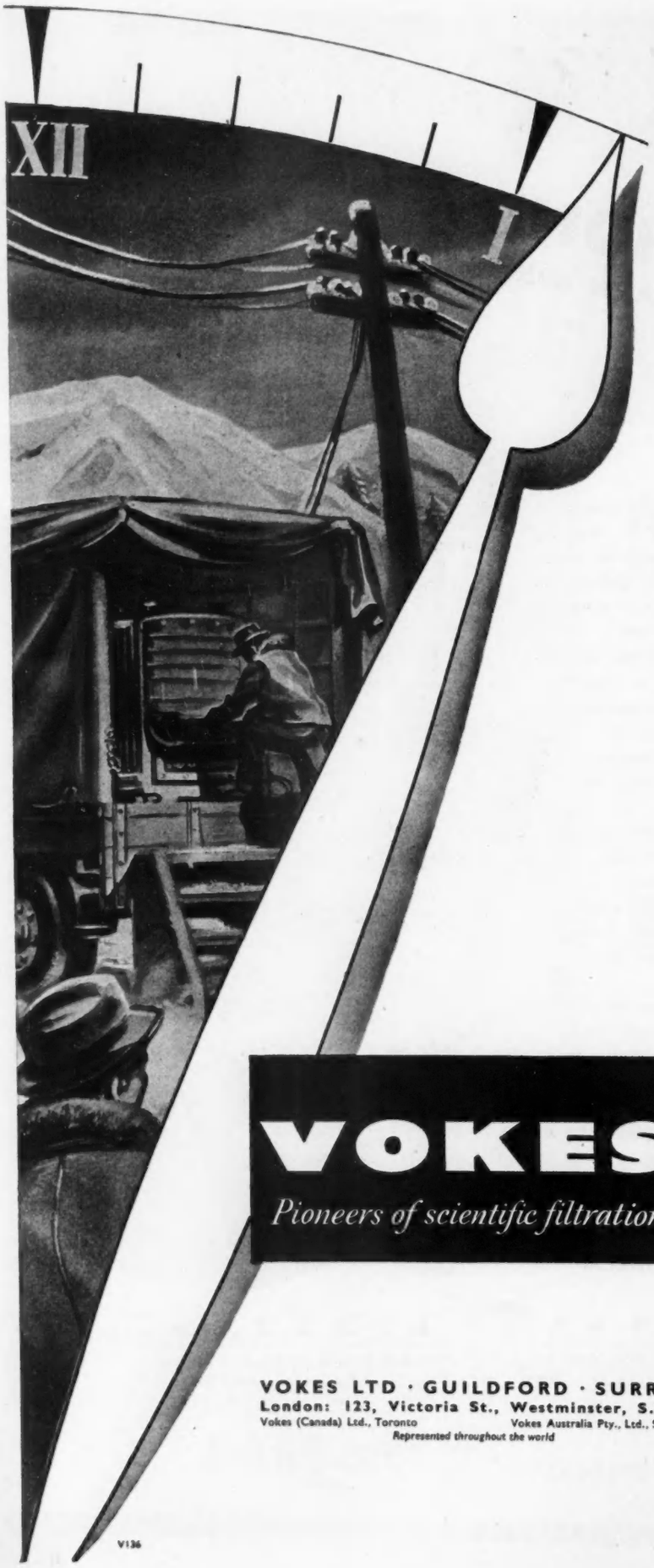

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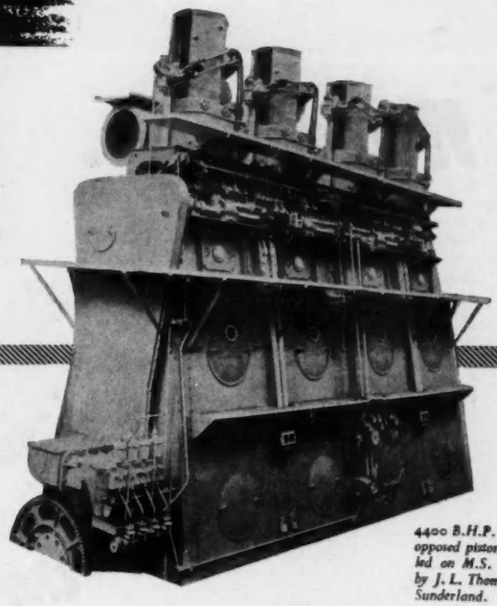
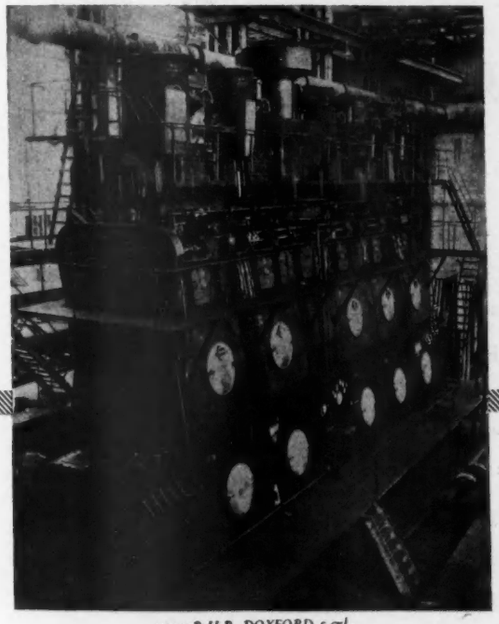


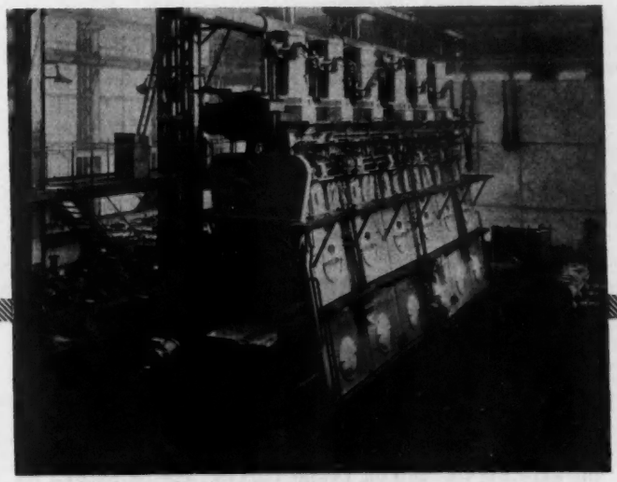
4400 B.H.P. DOXFORD 4 cyl. opposed piston oil engine, installed on M.S. Thistledown, built by J. L. Thompson & Sons Ltd., Sunderland.



5150 B.H.P. DOXFORD 5 cyl. opposed piston oil engine, as installed in four sister ships built by William Doxford & Sons Ltd. Sunderland.

In addition to their steel plates for shipbuilding constructional purposes, Appleby-Frodingham supply large quantities of Appleby Plates to engine builders and for other duties in the mechanical equipment of ships. All the engine housing plates for the engines illustrated were supplied by Appleby-Frodingham.

The photographs are by courtesy of William Doxford & Sons Ltd., Sunderland.



6400 B.H.P. DOXFORD 6 cyl. opposed piston oil engine, installed on M.S. British Reliance, built by Sir Jas. Laing and Sons Ltd., Sunderland.

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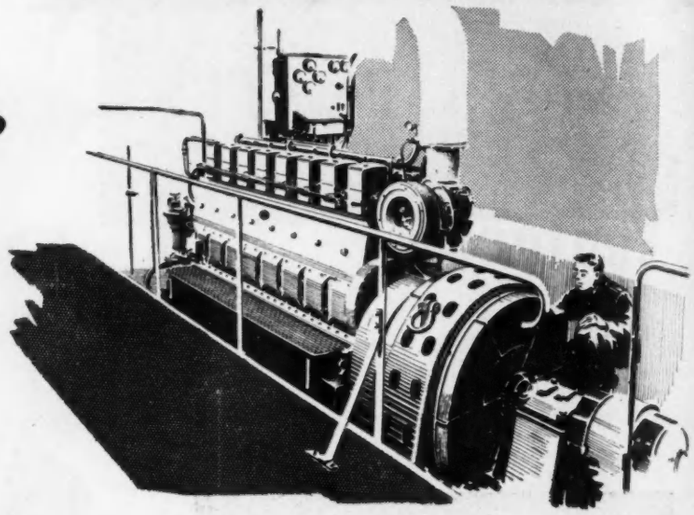
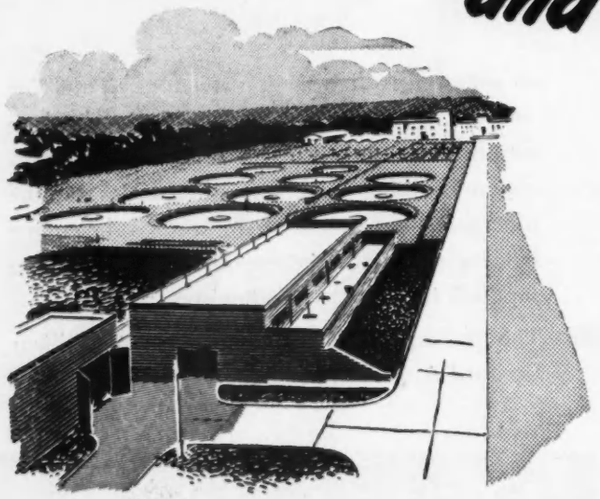


and wherever...



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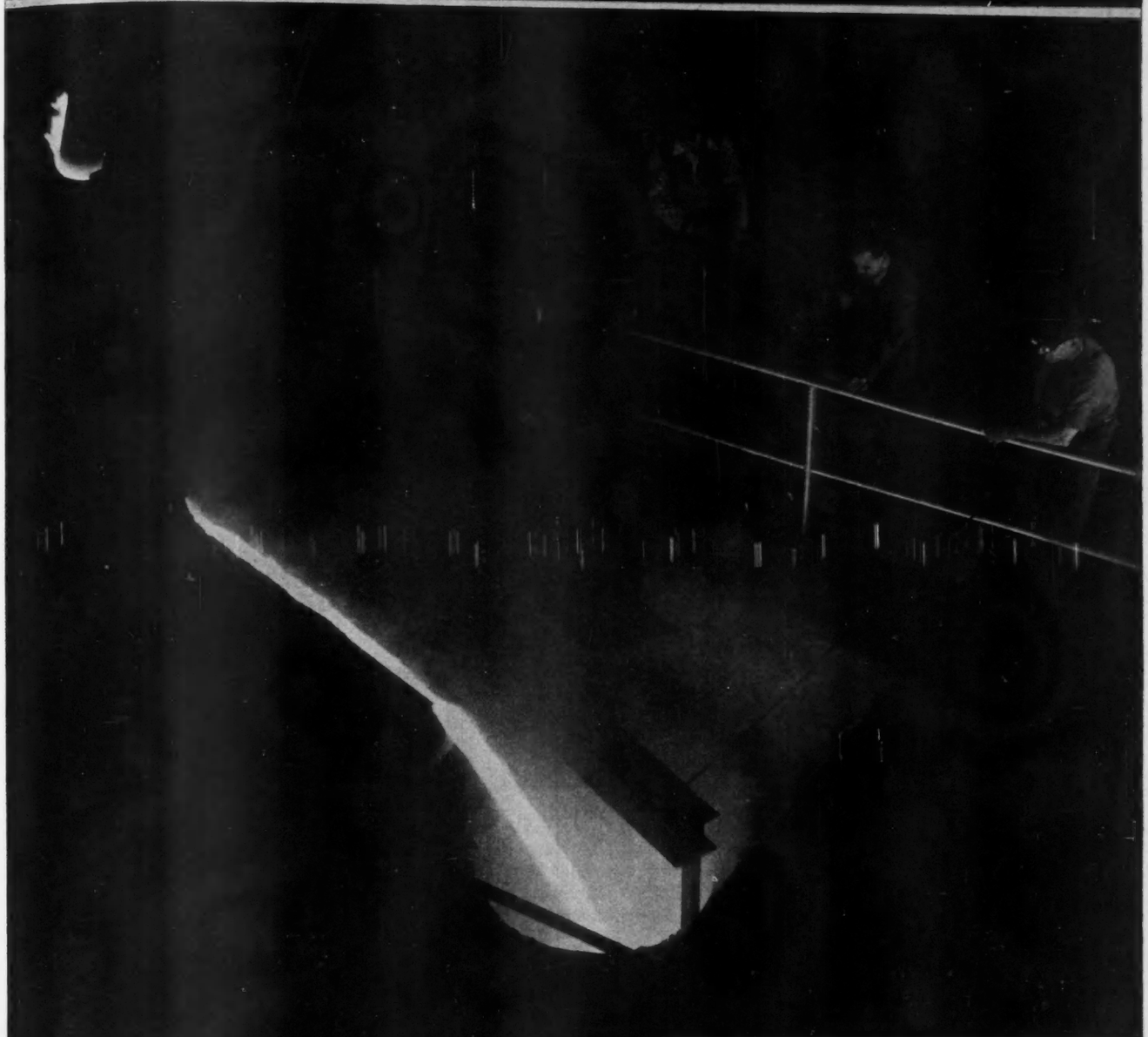

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Soap Powder	19/30 „	70/80 „
Cement	14/20 „	20/30 „
Tungstic Acid	10/15 „	2/5 „
Magnesium Trisilicate	4/9 „	20/30 „

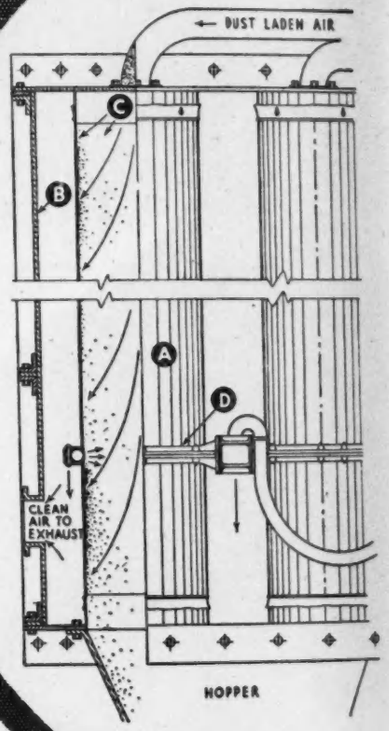

Diagram showing operation of the MIKRO-COLLECTOR — *Felt Bag (A) is clamped in housing (B). Dust-laden air enters from top (C). As the air passes through filter medium, dust deposited on inner surface of bag is dislodged by dual-action of cleaning ring (D). Cleaning is accomplished by counter-current of pressured air from ring and flexing of bag by ring as it moves up and down continuously.*

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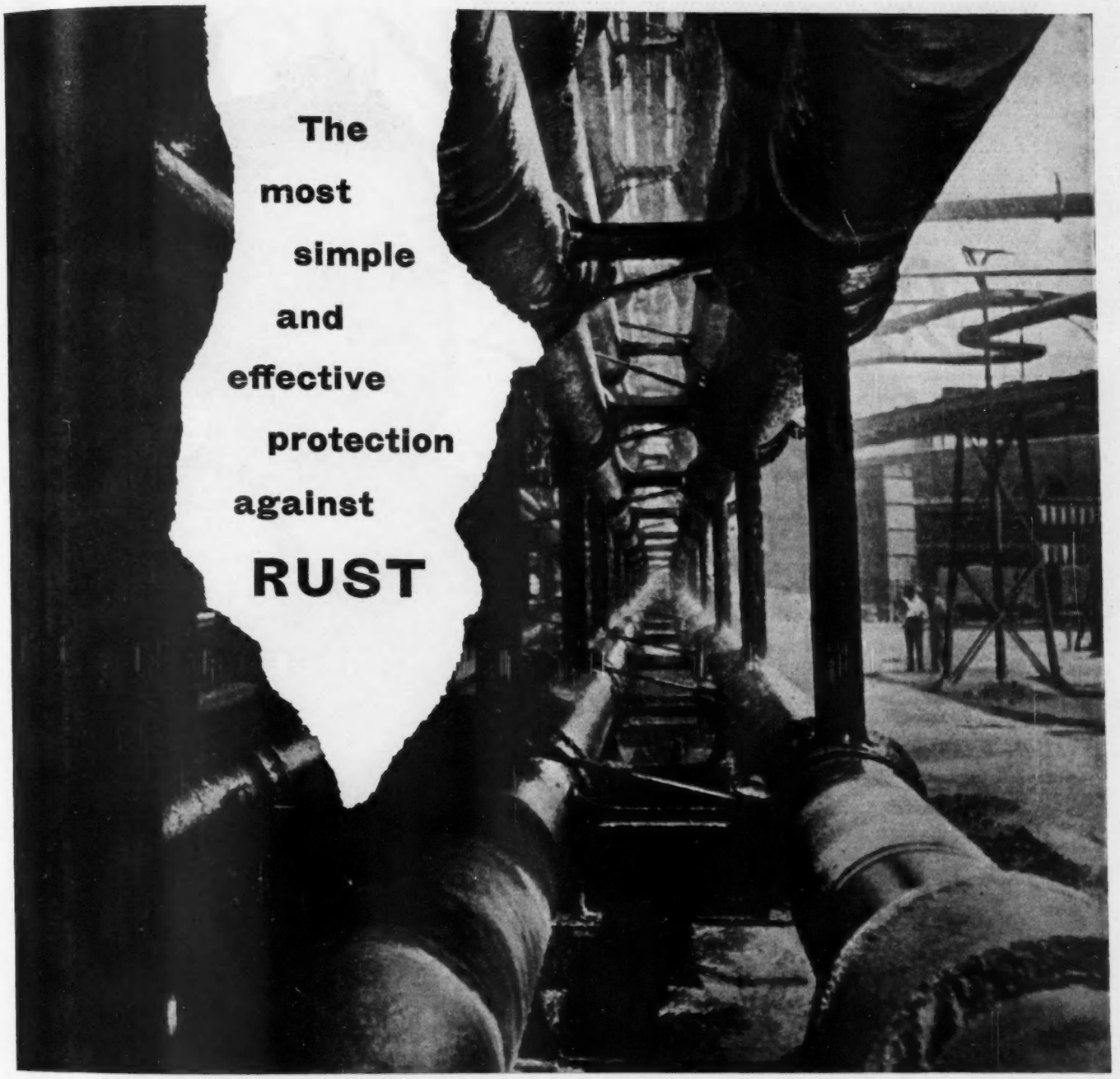

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ENGINEERING

An Illustrated Weekly Journal

Vol. 181 No. 4701 APRIL 13, 1956

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THE FORWARD LOOK

IN engineering more than in any other profession or industry, the ability to look ahead, to make a shrewd forecast of the future, is invaluable. Fifty years is not too long a time for big firms to reckon with, and their forecasts may serve as a reasonable context in which smaller firms can plan ahead for ten or twenty years.

The chairman of Associated Electrical Industries, whose annual address is referred to elsewhere in this issue, must necessarily paint his picture of the future on a broad canvas: "It seems to your directors that such industries as the chemical and electrical industries must be among the leaders in the last half of this century." Come wars hot or cold, trade slumps mild or severe, that supposition must be accepted. It assumes that Britain will continue to hold her own in the world, and by so assuming it provides the impetus needed to turn the assumption into reality. His view of the future is based on the probability that the use of electrical energy will be doubled every ten years as it has been in this country since 1900. In oversea countries which are now being industralised the increase may well be even more spectacular.

There are several branches of engineering which the chairman of A.E.I. regards as typical of future trends. Of the cost of nuclear reactors about 10 per cent. will be spent on various electrical devices associated with the reactors, and as much as 30 per cent. will go on conventional equipment such as turbo-generators, switchgear and transformers. On railways at home and abroad electric and Diesel-electric traction will expand rapidly. In electronics new uses for apparatus, civil and military, are constantly being developed, and the uses of semi-conductors and of germanium for power rectification are being extended.

But this fascinating prospect must be set alongside another, less welcome. The inevitable decay of some other branches of engineering must be foreseen and its implications accepted.

★ ★ ★

THOSE whose job it is to forecast long-term developments in international trade have a new major factor to take into account. The entry of "political" trading by rival power groups during the next few years is likely to alter radically the established pattern of trade between nations. Already, many British engineering companies have experienced the difficulties of trading successfully in countries receiving substantial economic aid from the United States. Since the war, U.S. foreign aid has averaged over 4,000 million dollars a year, mainly military; experts now advocate an annual expenditure of some 2,000 million dollars on spurring economic development in under-developed countries. The much-publicised objective is "to fight the cold war on the economic front."

Since the death of Stalin the Soviet Union has entered the lists with considerable initial success, particularly in the East. India has been offered credit at 2 per cent. (the rate charged by Britain is believed to be 6½ per cent.); a project for a steel works of one million-ton capacity has been accepted, with the Russians supplying the bulk of the plant and all the technological know-how. A Russian team carried out a general mineral survey of the country and reported large oil reserves; the team impressed by their experience and efficiency, and the Russians were quick to offer, at the highest level, "assistance, guidance and facilities for training Indian personnel." An Indo-Soviet trade agreement is being negotiated and a shipping agreement has recently been signed.

In the Middle East, Soviet efforts have been even greater. The pattern is now familiar: high-level political tours, economic missions, surveys and then offers of economic assistance. An atomic co-operation pact has been made with Egypt which provides for the loan of technicians who are to build a national atomic institute with Russian-made equipment and also search the desert for uranium. Lebanon and Syria, the Sudan and Turkey are now being submitted to the "full treatment." In each case plant is being offered, technicians supplied, arrangements made for the training of nationals in the Soviet Union. Where capital is not loaned at low rates, payment for supplies and services is taken in kind, i.e., whatever is the particular country's main export surpluses over many years. Offers have even been made to develop road and rail systems on those terms.

Every Soviet effort sparks off an additional effort by the United States and, in some cases—Indian steel for example—by this country. The effect of such competition on world trade has yet to be worked out: it could be immensely beneficial in increasing the volume of world trade (as the industrialisation of Japan increased her imports of British goods between the wars.) It will certainly change the pattern of trade and impose on our industry a rate of adaptability it may find hard to work up. But the main British disadvantage is political: we are light-weight and too easily maligned. Yet we could train in Britain far more of our customers' nationals and we could send out far greater numbers of our technolo-

gists. Unfortunately—and perhaps fortunately also—profit and not political gain is our prime mover. Could it be perhaps that we are next on the list and that B. & K. will be followed by Mr. Mikoyan, Mr. Melnikov and the Technoexport Corporation?

* * *

Plain Words

Current talk of the shortage of engineers must sound remote and unrealistic to an engineer who is himself not fully employed. He may ask, with good reason, whether an inquiry into the present employment of engineers is not at least as important as the steps which the Government and industry are taking to increase the number in the future.

An inquiry which may throw some light on the use made of engineers is being carried out by the Ministry of Labour in co-operation with the Department of Scientific and Industrial Research. The object of the Ministry's part of the inquiry is to find out how many professionally qualified scientists and engineers are now employed, and how many industry estimates will be employed in three year's time, on the assumption that sufficient recruits would be forthcoming. The D.S.I.R. are seeking information about the proportion of national resources spent on research. Inquiry forms are being circulated on a sampling basis by the Social Survey Division of the Central Office of Information. In addition, the Ministry of Labour side of the inquiry is being extended to the nationalised industries, to national and local government service, and to the universities.

Apart from the fact that the results of this inquiry are not expected to be available for some time, it is unlikely that they will indicate the effectiveness of employment of engineers, for how can the effectiveness be measured without a searching examination of individual firms and nationalised industries? Such an examination should be carried out individually by the firms and industries themselves. In view of the present shortage of engineers there is no doubt that such an examination is over-due. We have already asked the nationalised industries for their figures of professional engineers, but it is apparent from the replies received that, in most cases, the information is not available. There is no check on excessive employment. It would be misleading to quote the few figures that were provided since they are not strictly comparable, but it seems probable that some industries have too many, and some too few, engineers.

If each firm and each nationalised industry would initiate its own inquiry the apparent shortage of engineers might be exposed as a myth and men made available for projects which are at present held up on this account. Improvements in organisation would almost certainly be an indirect gain, since routine work might be transferred to others less well qualified, leaving professional engineers to do the creative and managerial work.

HOW THE DEAD SEA SCROLLS WERE OPENED

By Professor H. Wright Baker,
D.SC., M.I.MECH.E.

The discoveries made since 1947 at Qumran, near the north-west corner of the Dead Sea, must surely be amongst the most interesting in the history of archaeology. The story of the chance discovery, high up in the face of a cliff in this beautiful but utterly desolate region, of a cave containing jars, each carefully sealed, begins like a time-honoured fairy story, and becomes only the more fascinating as fancy gives way to fact.

In the jars were found scrolls of leather and of papyrus carefully rolled in linen and covered with a pitch-like material. In other caves the unprotected fragments of very many other scrolls were subsequently found. The presence of so much material within a restricted area led to the exploration of a hitherto unexamined mound standing on the cliff-top above the first cave and having the name of the Ruin. Here a team of archaeologists, working with the Department of Archaeology of the Government of Jordan, and under its Director, Mr. Lankester Harding, have now revealed the buildings of a considerable settlement of a religious Order, with living quarters, a scriptarium—even complete with ink-wells—a watch tower and an elaborate system of water-channels and reservoirs. Not far away are the graves of a large cemetery. Among the ruins have been found jars containing some hundreds of coins which have enabled the dates of occupation of the settlement to be traced. Obviously the scrolls have formed part of the library of the settlement, and as the work of translation has proceeded, have proved to be copies of all but one of the books of the Old Testament, made some thousand years before those from which our present translations were copied. Among them also was the "Manual of Discipline" of the Sect and other writings of their day, and there is gradually being pieced together for us the story of the religious group of the Essenes which broke away from the corruption and domination following the Roman occupation and withdrew into the Wilderness, there to live till the settlement was finally laid waste about 68 A.D.

From the fascinating accounts to hand it is clear that, in the hands of the very fine team of archaeologists and scholars working in Jordan, there is now material which will throw much new light on the history and understanding of both the Old Testament and the opening stages of the New, and will help to draw together into a single fabric threads which history has so far seemed to hold apart.

SCROLL OF "BRONZE"

During the explorations of 1952 a new cave was discovered containing two scrolls of bronze or copper which were found deeply embedded in the fine dust which covered the floor where they had lain for perhaps two thousand years. Here were new and tantalising problems.

The scrolls seemed originally to have formed a single plaque of impure copper, beaten to a thickness of 0·03 or 0·04 in., and built up from three pieces riveted together so that the total size was about 8 ft. by 11 in. The plaque had been lettered with a small punch,

Fig. 1 One of the two "bronze" scrolls from Qumran which were sent to the College of Technology, Manchester, to be opened.

presumably while resting upon a relatively soft base—probably wood—so that the back surface was raised with a patterning about 0·04 in. high, but varying very considerably in height. The sheet had then been rolled, apparently in considerable haste, or without due appreciation of the hardening and stiffening effects of the lettering process. The first riveted joint was much strained during the rolling, and the second joint failed entirely, so that in the end two rolls, each about 4 in. in diameter and 11 in. long, were produced.

The scrolls of leather and papyrus had proved to be documents of a biblical nature, or related to the domestic and other matters of the Sect, but the "bronze" scrolls because of their unusual material and method of lettering, the strange procedure of rolling a metal plaque, and because of the apparent haste, raise many new questions. Yet there they lay, filled with dust, corroded, cracked and in places broken, and embrittled till they fractured at a touch, and with adjoining layers bonded together, literally clasping their secrets to their hearts. The copper had gone and only the oxides and other salts remained.

It seemed that unrolling, or metallurgical

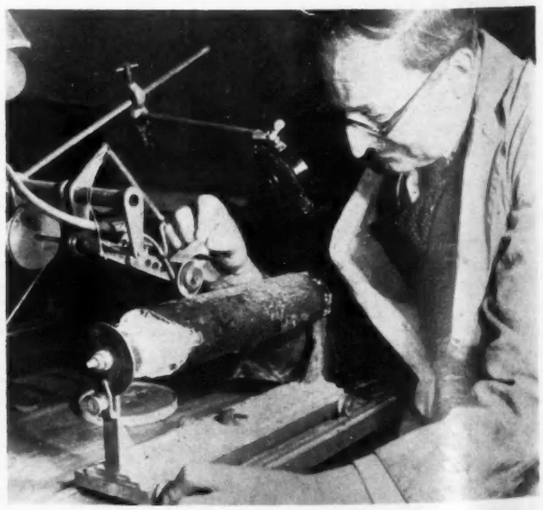

Fig. 2 Each scroll was mounted on a spindle, strengthened by means of a modern adhesive, and then cut into longitudinal segments.

methods of opening were out of the question owing to the nature and extreme brittleness of the material and the complexities and bonding of the roll, and that the only method which might be at all practicable was to cut the scrolls into strips parallel with the axis of the roll removing each with great care.

It was at this stage that an entirely chance conversation led to the writer being asked his opinion as to whether it was possible to cut old and decayed bronze, and which at once evoked the answer that the cutting should present no special difficulties but that it would be very desirable first to apply a tough backing, in the form of one of the modern adhesives, to prevent the detachment or displacement of fragments. The answer seemed to have been convincing as, to his immense surprise, the first of the scrolls was brought from Jordan within a few weeks and was laid upon his desk at the College of Technology, Manchester. The theory of probabilities seemed to have gone wrong.

CONDITION OF SCROLLS

Scroll No. 1 had been selected for the experiment as, though it was the same diameter as No. 2, it consisted of only one sheet of metal and the turns were generally separated to a much greater extent and were therefore less likely to be joined by adhesions. It was also much more robust.

A freshly broken surface of the "metal" showed a highly crystalline structure, suggesting the early penetration of corrosion along the crystal boundaries. The colour was a brilliant red (cuprous oxide) interspersed with bands of a brown material, obviously the remains of slag-bands formed during the original forging process, and which occasionally broke through to the surface, allowing corrosion to penetrate beneath. Analysis showed an original tin content of about 1 per cent., the remainder being copper, but virtually no metal remained. The surfaces of the sheet were covered with copper oxychloride of a yellow-green colour, the lower portions adhering strongly to the base, while the upper portions varied from a dense mass, often binding adjacent layers with considerable tenacity, to a very fine powder mingling with the mineral dust with which the scroll was charged. The powder, being highly irritant, had to be drawn away from the operator during cleaning, by a suction fan discharging into a filter bag. A relatively soft decomposition product of a bright blue-green colour was sometimes found superimposed in considerable depth over the yellow-green matter.

The material which presented the greatest difficulties was a very hard stone which had formed from the mineral dust, sometimes as a very localised surface layer, at others as small "droplets," or as a stalactitic formation overlying the green products, and in a few cases in Scroll No. 2, as a bonding agent of great strength between contiguous layers. In a few cases pieces of one turn of the scroll had torn completely from their places and were found rigidly attached to adjacent turns, and there were a large number of cracks running in both longitudinal and circumferential directions.

TECHNIQUE OF OPENING

The procedure adopted to open the scroll was in four stages—first, the mounting of the scroll in such a way that it could be manipulated without direct handling and with the minimum risk of mishap; second, the application of the backing solution; third, the actual cutting, which had to be carried out with the least practicable forces and be controlled by a delicate sense of touch; and finally the release and lifting of the severed sections. These are described in the following paragraphs.

The dust, etc., lying at the centre of each scroll was gently worked out, allowing the insertion of a spindle which projected at each end. This was then packed carefully into position with dry dental plaster rammed gently into place, the same material being used to support the convolutions where the native dust had left them unsupported. A thin layer of moist plaster was applied to maintain the dry plaster in position. Wooden guard discs, one of which was registered and indexed, were threaded over the spindle ends, with a clamping disc, the spindle then being supported between two trunnion bearings on a suitable frame which could be clamped by a central bolt to the table, or to the slide of the sawing machine, or be transferred to the oven mentioned later.

The scroll, which could now be rotated on its frame and locked in any desired position without handling, was then cleaned using dental equipment and polishing brushes, after which it was coated with Araldite 102, with hardener 951, and a small quantity of toluene, and maintained at the gentle temperature of 40 deg. C. for a few hours in an electric oven. The effect of this treatment was to transform the brittle sheet of salts into a tough material which could be handled with full confidence. Even when complete fracture through the sheet occurred, the fragments were held together by the coating, and losses proved to be quite negligible.

The scroll and its mounting were then transferred to the carriage of a specially designed sawing machine. The saw, 1¾ in. in diameter and 0·006 in. wide, could be applied by very light finger pressure to the surface of the scroll, which was moved parallel to its own axis on a kinematic slide operated by a knurled projection on one of the wheels. Full provision was made on the carriage for the adjustment of the scroll beneath the saw to obtain the best possible cutting position, judging this from the configuration of the scroll and the position of the letters as indicated by the raised patterning on the back of the plaque. In several cases it proved possible to run the cut in the blank spaces discovered between the columns of lettering.

Except where contact was made with stony matter, the actual time of cutting varied from two and a half to ten minutes, the process being seen in detail through a powerful magnifying glass, and the dust removed by a small air jet.

After the sawing, the scroll was removed from the machine, still supported on its frame which was then pivoted and clamped to a work-table. In general the segment could then be freed from the dust which lay beneath it and lifted clear. In other cases bonds of corrosion products had formed between adjacent surfaces and had to be broken down by prising or by sawing, using flexible strips broken from the edges of the circular saws. In only a few cases was very serious difficulty experienced. Each external surface exposed was treated with Araldite and seriously cracked surfaces were strapped with Perspex.

The loosened segments were then brushed free of dust and the lighter corrosion products, this process usually being sufficient to show the lettering in excellent condition. Patches of corrosion products could be removed with a dental burr, using the changing colour of the various layers of matters as a guide.

The method of punching the letters had produced a characteristic shaping of the metal surface, the letter-line forming, as it were, a dry stream-bed between adjacent rounded hillsides. By lowering the general level of patches of deep corrosion products the hilltops were the first to appear. By moving the burr gently across the valleys thus indicated the contours could then be revealed successively until the burr settled down into the stream-bed up which it would slide easily, displacing the deposit in the groove—usually soft—with ease. This procedure made it possible to trace the lettering with certainty, and to disallow surface irregularities due to corrosion, corrugation or cracking.

In order to minimise the loss due to any possible accident some hundreds of photographic records were made, but these have happily only been needed for the preparation of the transcription. It is immensely satisfactory to know that of more than 3,000 letters originally on the plaque not more than 5 per cent. are missing due to breakages of very long standing, and of the remainder only about 2 per cent. seem doubtfully clear, even allowing for the

Fig. 3 Loosening the sand and breaking the bond of corrosion. The dental burr used for removing the corrosion products is visible behind the scroll.

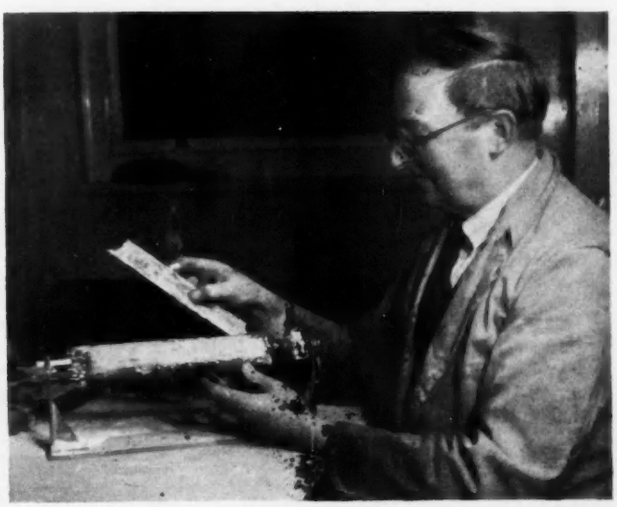

Fig. 4 Lifting a segment away from the scroll. Of the 3,000 letters punched in the scrolls none was lost by the cutting and opening process.

heavy bonding encountered, and none has been lost through the sectioning.

The curved inner surfaces of the segments, which had formed the face of the plaque, were photographed in a number of radial directions. The resulting prints naturally showed a very large amount of irrelevant detail which tended to obscure and confuse the lettering. The lettering was therefore picked out in white ink and then traced on an enlarged scale in such a way that a single picture of the whole plaque was obtained. The tracing was then compared and checked in detail with the actual scroll sections.

And what is it all about? Even a buzz-saw operator can wonder why one who used such strange and costly writing material should lay out his work and form his lines and letters with such imperfect skill and crowd them both towards the foot of a column; how the plaque was to be used—for there is no sign of any means of suspension—and why he should attempt to form such intractable material into a small roll, and do it with so little skill, or in such haste.

It would be both idle and dangerous to speculate on these things, or to make conjectures about the meaning of the words or the significance of the record when, before long, we may have the report of the team of scholars now working upon the transcription in Jordan. In sending them his very best wishes for their success, the writer would express his own deep indebtedness to the Government of Jordan and their representatives who have enabled him to play such an intimate part in solving one of the fascinating problems of Qumran.

Letters to the Editor

PROTECTING STEEL FROM WEAR BY PHOSPHATING

SIR, It is well established by nearly 20 years industrial usage that phosphating is one of the more successful means of providing wear protection for steel. Until recently no systematic study of the protective action had been reported and the mechanism by which the protection is afforded remained obscure.

However, results recently obtained on the wear characteristics of a phosphated mild-steel thrust bearing[1] showed that under conditions of low load (43 lb. per sq. in.) and moderate speed (35 ft. per second) using a lubricant (kerosine) of low viscosity, the protection which persisted after running-in could only be ascribed to the maintenance of either hydrodynamic, or thin-film lubrication, facilitated by the particular modifications of the surface profile which result from the phosphating process.

The investigation has now been extended to much higher loads (up to 4,000 lb. per sq. in.) at a speed of 0·92 ft. per second using B.P. medicinal paraffin as lubricant. The friction and wear characteristics of run-in specimens again clearly show that, even under these conditions, the lubrication is not of a solid or boundary type, but is either of the hydrodynamic or thin-film type.

In arriving at this conclusion, the following possibilities have been carefully investigated, but have been found not to play a significant role in the wear protective action:—

1. That α-iron may be preferentially removed from the surface, this constituent being said to be that which forms surface welds most readily.[2]

2. That the phosphate crystals may be ploughed into the surface, enhancing its hardness.

3. That the phosphate crystals may act as a solid lubricant, possibly by the formation of the so-called "phosphate glass."

The conclusions reached are based on the following observations which have been made on mild steel processed in an accelerated iron-phosphate bath, or alternatively in an accelerated iron-manganese-phosphate bath, both of which were found to give similar results.

(*a*) Wear tests have shown that significant, though not long-lasting, wear protection is given by phosphating for times as short as one quarter of that normally employed industrially.

(*b*) During such short processing times few or no phosphate crystals are deposited, as observed microscopically, and more sensitively by electron diffraction, but the surface is preferentially etched. As this etching proceeds, interconnecting surface channels are formed leaving plateaux which later on a fully phosphated specimen, become covered with phosphate crystals.

(*c*) If the phosphating time is only a quarter of that normally employed, the heights of the plateaux are only 0·0002–0·0003 in., about one third of the plateau height in a fully-phosphated specimen. Under the conditions used, this plateau height is found to be only just sufficient to survive the runing-in period and shortly afterwards the plateaux are completely worn down over an appreciable area of the bearing surface; when this occurs gross wear and seizure results.

(*d*) On subjecting a fully phosphated specimen to wear, the phosphate crystals are very soon removed from the plateaux tops, leaving them to form the bearing surface. The composition of the bearing surface so formed has been identified and found to be identical with that of the bulk mild steel and not depleted in α-iron as suggested by Roosa.[2] The bearing plateaux are the cathodic areas of the surface and their size and distribution apparently largely depend on the distribution of surface strain.

(*e*) With run-in specimens no evidence has been found of solid lubrication by the small proportion of the deposit which survives the running-in period. Cessation of the lubricant supply results in immediate seizure. The black shiny appearance of run-in phosphated steel is due not to the formation of the so-called "phosphate glass"[3] but arises from the combination of the highly-reflecting relatively smooth bare plateaux tops and the diffuse scattering from the rough-faced channels.

(*f*) The hardness of run-in fully phosphated mild steel is not significantly higher than that of the untreated mild steel.

(*g*) When lubricated with medicinal paraffin and run at slow speed and high loads, the coefficient of friction at room temperature is very low (μ=0·005–0·012) for loads up to 4,000 lb. per sq. in; it is also strongly dependent on both pressure and temperature. These are the friction characteristics of a hydrodynamic or thin-film lubricated bearing. In the pressure range 1,500–4,000 lb. per sq. in., μ increases with increase in pressure, but decreases with increase in viscosity, characteristics which in journal bearings correspond to the region of the μ versus $\frac{ZN}{P}$ curve known as "thin-film lubrication." This, together with the fact that breakdown in the lubrication becomes increasingly evident at the top end of the pressure range (i.e. 4,000 lb. per sq. in.) suggests that the term "thin film" is probably appropriate for the range 1,500–4,000 lb. per sq. in. The lubrication at these pressures is definitely not "solid", or "boundary," the friction of which would be much higher, μ= 0·05–0·10. In contrast, it should be noted that with untreated mild steel run under the same conditions, the coefficient of friction was ten or more times the above values, being μ=0·12, almost independent of temperature and pressure and obviously not corresponding to hydrodynamic or thin-film lubrication.

(*h*) The absence of intermetallic contact between the lubricated phosphate surfaces studied above and the breakdown of the lubricant film between the untreated mild steel, has been verified using a cathode-ray oscillograph electrical-resistance method in which electrical breakdown of the lubricant dielectric was controlled by restricting the power dissipated in the lubricant film to 30–50 microwatts.

(*i*) It has been found that under given conditions a phosphated surface can be successfully lubricated by a lubricant of much lower viscosity than can an untreated surface.

(*j*) The observation of Shaw[4] and Martz[5] that phosphating increases the scuffing load of a lubricated surface by up to 100 per cent. has been confirmed.

From the results obtained it is clear that under the wear conditions employed, in which the wear protection is well exhibited, the protection of run-in phosphated mild-steel is not significantly associated with change in surface composition, as suggested by Roosa[2], nor with enhanced surface hardness, nor coalescence of phosphate crystals to form the so-called "phosphate glass"; nor indeed is the protection after running-in apparently connected with the phosphate crystals at all. It should be noted, however, that there is some evidence to suggest that the phosphate coating may play a part during the running-in period by preventing intermetallic contact[6] and also by exerting a mild polishing action which smooths the plateaux-bearing surfaces and so promotes bedding-in.

All the results support the conclusion that the wear protection after running-in, and possibly during the running-in period too, arises from the particular form of interrupted surface profile which results from the phosphating process and which promotes the establishment of hydrodynamic, or thin-film lubrication, and thus reduces friction as well as wear.

Numerous examples are known where surface profile modification by mechanical or chemical means has resulted in wear protection,[2] although the present investigation is the first to prove that the phosphate protection is undoubtedly associated with this feature.

A full account and more complete discussion of the above investigations will be published shortly. The research formed part of the programme of the Mechanical Engineering Research Board and this communication is made by permission of the Director of Mechanical Engineering Research, Department of Scientific and Industrial Research.

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Yours faithfully,
J. W. MIDGLEY.

Chemical Engineering Dept.,
Imperial College of Science and Technology,
London, S.W.7.
March 2, 1956.

★ ★ ★

A "SILENT" MOTOR CYCLE

SIR, In a recent leading article, "Revolt Against Noise," you included motor-cycles among disturbers of the peace. May we point out that for some years we have produced and marketed a Velocette motor-cycle that is as quiet as, if not quieter than, many many motor-cars? It has become widely known as the "silent" LE model, and has a two-cylinder opposed water-cooled four-stroke engine. We have gone to considerable trouble in the design to cut out noise as far as is reasonably possible. Though it is rather difficult to hear them, you may have seen some of them running about.

Yours faithfully,
for VELOCETTE LIMITED,
R. W. BURGESS.

Birmingham.

Weekly Survey

Cover Picture: *The illustration shows oxygen cylinders being tested to a pressure of* 3,000 *lb. per sq. in. The cylinders are filled with water and immersed in water in a well, as shown in the centre of the picture. The well on the right contains a cylinder under test. When the test pressure is applied to the water in the cylinder, the latter expands and forces water out of the well into a gauge glass on the instrument panel. When the pressure is released the water level in the gauge glass falls. By this means the temporary and permanent expansions of the cylinder can be measured.*

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Investing Overseas

It has become fashionable since the war for Chancellors of the Exchequer to miss their estimated surpluses or deficits each fiscal year by a substantial margin. One figure, however, which has been used on Budget occasions looks like proving true. Some time ago Mr. Butler, when Chancellor of the Exchequer, said that this country ought to have a surplus on its balance of payments with the rest of the world of about £300 million a year. Only with a margin of this size could this country carry out the large-scale investment programme in the Commonwealth which politics and economics alike dictate.

In the White Paper on the 1955 balance of payments which was issued last week, the Treasury has made an estimate showing how this country's long-term capital obligations have been running since 1952. In 1953 and 1954 the total was about £200 million but it dropped in 1955 to £165 million. It seems almost certain that this figure will be exceeded in 1956, for the impact on this country's international accounts will be felt from the Indian steel project, the Egyptian dam at Aswan and the Volta River Scheme in the Gold Coast.

There is in addition a need to provide for contingencies which cannot be covered by much less than £50 million to £100 million a year. One way and another, therefore, the balance of payments in 1956 may well have to cope with obligations amounting to about £300 million. It is against these formidable figures that the recent modest improvement in the gold and dollar position must be judged.

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Size and Efficiency

Associated Electrical Industries Limited had a turnover in the calendar year 1955 of about £127 million. Its trading profit represented about 13·5 per cent. of its turnover. There are now signs that the A.E.I. giant is streamlining its group organisation in order to prevent the multiplicity of its interests building up a complex and inefficient board and top-management structure—a problem which affected some of the large German heavy industries before the war.

Two kinds of modification in the company's structure have become apparent in the chairman's statement this year. A new holding company, bearing the initials A.E.I. Limited, has been formed in Australia to acquire all the assets of the former Australian Electrical Industries Proprietary Limited. This new company will have Australian shareholders, most of them being the Australian public, but some of them employees of the company. A further £A2 million is being spent on this company's manufacturing facilities.

There are also changes at home, however, which are aimed at rationalising the complicated structure in the United Kingdom. A new company called Siemens-Ediswan has been created to combine the Siemens and Ediswan companies. This group is engaged in the production of telephones and cables, cathode-ray tubes and ancillary apparatus. The A.E.I. Lamp and Light Company which was formed in 1955, has now become an operational company in the B.T.H. group, which is the twin giant along with the Metropolitan-Vickers Electrical Company, Limited, within the A.E.I. group as a whole. The rationalisation of lamp manufacture is reported to have gone well and sales arrangements have been brought to the point where the company can trade as an integrated unit. Quite distinct from the general run of the company's activities is the Hotpoint Company, which sells electrical equipment to the public through the retail market. This company has now been entirely separated from the other general engineering activities. Thus the group as a whole is moving towards a functional re-arrangement of its activities to replace the historical grouping which evolved as various companies and groups of companies have been taken over in the last half century.

It will be surprising if this functional grouping does not go further in the next few years, for there are already signs that it has achieved some successes.

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Electrical Consultants to India

One of the features of Lord Chandos's statement to A.E.I. last week was the 15 year contract with the Indian Government to act as consultants in building heavy electrical equipment. This arrangement was announced some time ago and at the end of last month a further statement was issued from New Delhi that the English Electric Company, Limited, are to act as consultant in the manufacture of hydraulic turbines and associated equipment. This tie-up between English Electric and Associated Electrical Industries will thus enable A.E.I. to design and lay out a complete heavy electrical equipment factory to meet the needs of hydro-electric equipment in India. Training of Indian engineers will take place both in this country and in India.

The contract is of the highest importance. In the face of acute competition, this country has secured for 15 years a continuing association with heavy electrical developments in India. It follows from such an arrangement that all British potential suppliers of electrical equipment to schemes covered by the consultancy arrangement cannot but be in a slightly favourable position to secure orders. There are, of course, other points of advantage as well as the sales opportunity which must exist for British companies when the resident consultants are from this country. Indian engineers will be trained in the tradition and with the mental outlook of British engineers so far as design, specification and supply of equipment are concerned. This is itself of great advantage. It is a formula that has been tried out with advantage by other industries (locomotives, for example) and might be continued by others.

India (and there are other countries in a similar position which will be developing their natural resources) is short of technical knowledge and trained managerial ability. This lack cannot be made good at short notice. On the other hand, the Indian Government shows every indication of pressing on as quickly as possible with an ambitious programme of industrialisation. The decision to force on the capacity of the Indian steel industry from 2 million to 6 million tons a year by the early 1960's is one example. In such circumstances the idea of a consultancy contract secures for the underdeveloped territories the essentials of economic independence with a continued association with a sound industrial tradition.

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Racing Drivers and Others

Automobile manufacturers in the United States are now actively selling "survival," and those in Europe will soon be forced to do likewise. Steering wheels with recessed centres, padded instrument panels without projecting knobs, door locks which retain their grip in an impact, safety belts, better driving vision, tubeless tyres, and more powerful brakes, are helping to reduce accidents and to minimise the effects when a collision occurs.

Engineers are constantly engaged in efforts to make vehicles safer, but in England they are entitled to feel aggrieved at the lack of effort in the construction of modern roads, which would be the biggest single contribution to road safety. There is another notable omission: the lack of opportunities for drivers to learn the finer points of driving. The driving test ensures that a person can manipulate a vehicle and can give a few hand signals which most people soon forget. But real driving skill has still to be acquired, and relatively few drivers ever achieve it.

This is a sphere in which the Automobile Association or the R.A.C. might usefully have employed some of their great wealth, but it has been left to the Buckinghamshire Police to take the initiative by setting up a concrete track on a disused aerodrome where drivers can learn to control skids, and improve their skill under the guidance of experts.

It might be thought that racing drivers were better off, but a study of the background to some recent casualties shows the lack of any organised method by which a driver can develop his skill without endangering himself and others. The fortunate few, like Moss and Hawthorn, are launched progressively on their careers by parents or guardians possessed of sufficient money and enthusiasm to provide them with suitable vehicles and advice. Others muddle along, buying or borrowing vehicles where they can, deprived of any systematic guidance unless they happen to achieve the success which produces an invitation to join a properly organised factory team. The care and skill which go into the preparation of the cars are rarely matched by proper preparation of the drivers.

Special interest therefore attaches to the training courses which have been organised by the Swiss Auto Racing Club in association with the Automobile Club of Switzerland for several years past. Students receive lectures on driving, competition rules, driver psychology and kindred subjects, supplemented by rides as passengers in fast sports cars driven by front-rank professional drivers. They then take their own cars round the circuit, and under the eyes of the instructors, who advise on the correction of faults. Leading Italian and German manufacturers have been supporting these courses by lending cars, and allowing their drivers to act as instructors, for there is a serious shortage of top-rank drivers. About 120 students are expected to attend this year's event at Monza in May.

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Technical Education in China

"Of the 47,000 students who graduated in China in 1954, 15,000 were engineers. In other words, the number of graduating engineers in China in that year was two-thirds that in the United States, five times that in the United Kingdom, and a quarter that in the U.S.S.R. At the present time, 40 per cent. of the University population of China is specialising in engineering, so that by 1957 China will probably be producing between 25,000 and 30,000 university trained engineers a year."

These startling figures are quoted from reliable Chinese sources in an article on technical education in China in the February, 1956, issue of *China Trade and Economic Newsletter*, published by the British Council for the Promotion of International Trade.

The rapid industrialisation of China which began in 1949 created an enormous demand for technologists and technicians. Since that year, the major stress in university education has been on the development of engineering colleges and natural science departments. The technical faculties in the older universities were amalgamated and re-organised into 20 new polytechnic institutes, specialising in steel, mining, and geology. The last-named of these subjects is of particular importance to China because of the

long overdue survey of her mineral resources undertaken by the new régime, which constitutes one of the fundamental bases of its economic planning: there are two geological institutes in Peking, one devoted entirely to petroleum, and a third at Changchun. The total number of students in higher educational establishments has been raised from 139,000 in 1950 to 258,000 in 1954, and will be raised still further to 434,000 in 1957.

The Chinese Government expanded also the intake of young people of both sexes in the technical schools. Thus the number of technicians (of all types) under training was increased from about 250,000 in 1950 to 608,000 in 1954, and will reach 672,000 in 1957. The number of these who completed their training and immediately found employment in their various trades rose from 13,600 in 1953 to about 170,000 in 1954, and will continue to increase annually. These numbers fall far below the needs of China's fast-expanding industry, and the gap has been filled by an extensive system of part-time training for workers at the mines and works, in night schools and by correspondence courses. These part-time courses, which include also courses for technologists, are organised by some 80 institutes and technical schools, with an aggregate enrolment, in 1955, of the order of 220,000, apart from those run by some of the major industrial enterprises, in which as many as 80 per cent. of the employees, in some cases, participate.

The demand for trained technical personnel at all levels will continue to outrun the supply for many years to come. This is inevitable on account of the shortage of teachers at both the university and secondary school levels. To overcome this shortage, plans are under discussion for trebling the number of teachers' training colleges and for supplementing such colleges with night schools and correspondence courses.

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Ball and Roller Bearings

The announcement of an increase in net profits of the Hoffmann Manufacturing Company from £509,280 to £536,688 in 1955, was accompanied by a statement from the chairman, Mr. J. W. Garton, that there is at present a very good order book but that some slowing down in demand is expected. This warning underlines the growing dependence of ball bearing manufacturers on the motor vehicle industry.

It is estimated that over the past four years the volume of output of ball bearings has increased by about one-third and that the proportion of total home consumption accounted for by motor vehicles has risen from under 50 to about 60 per cent. In the short term the present recession in the motor vehicle industry must result in a fall in demand for ball bearings, though the extent of the fall will depend on whether the recession extends to commercial vehicles as well as private cars. Although the monthly output of commercial vehicles is rather less than half that of private cars, a commercial vehicle uses more bearings than a private car.

In the long term there are prospects of greater diversification of demand, particularly in connection with the railway modernisation programme and the growing demand for precision bearings for machine tools. Exports of ball bearings have shown practically no change over the last three years but those of roller bearings increased by 16 per cent. in 1954 and 36 per cent. in 1955. There is also a steady demand for replacement bearings, accounting for perhaps 20 per cent. of the home consumption of bearings. Provided the motor industry recovers, therefore, ball bearing manufacturers can look forward to a continuance of the upward trend of demand.

That appears to be the view of the Hoffmann Company who have stated that their capital equipment programme, which is being financed from internal resources, will continue. In 1955, expenditure totalled £340,000 and at the end of the year capital commitments amounted to £420,000.

Information for Management

The technical library in an industrial organisation is most often born of a demand by the research and design departments; its potentialities for helping to solve the problems and saving the time of the production, financial and marketing sides are often not appreciated either by these departments themselves or by management. The librarian or information officer with a true vocation, however, cannot rest content with serving only a fraction of his organisation. For this reason, the Aslib Aeronautical Group of librarians and information officers, who recently held their fifth annual conference at Cranfield, Buckinghamshire, invited the British Institute of Management to discuss with them how the technical librarian can best assist management.

In considering information services for management, there are in fact two aspects: how to answer the demands of enlightened managements who are aware of the value of such services; and how to arouse the interests of the far larger group who are not yet conscious of these benefits. Both these questions came under discussion at Cranfield.

In serving technical and financial management and the marketing side of the business, the librarian accustomed to the needs of the research scientist will need to adapt a different approach and to seek new sources. He should be prepared to sift his information more finely—particularly when serving the non-scientific managers who, it appears, tend to be less critical of the written word than their colleagues in the research department; and he must pre-digest his findings and deliver them without delay, even to the extent of issuing his own daily news bulletin. He needs to keep in touch with all technical developments, economic and commercial trends, materials supplies and government actions likely to affect the operation of his organisation, in order that his directors may have always before them a picture of the future on which to base their decisions.

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Water Power in Scotland

The North of Scotland Hydro-Electric Board report that during 1955 the output of their hydro-electric, steam and Diesel stations was 1,405 million killowatt-hours, a decrease of 142 million kilowatt-hours compared with the figure for 1954. This reduction was due to an extraordinary and long-continued drought and had serious repercussions on both income and expenditure, which had already been upset by continuing inflation. Not only were sales to the South of Scotland substantially diminished, but it was necessary to import some 59 million kilowatt-hours from that area, including the cost of burning more coal at the Board's own steam stations, the extra financial burdens amounted to about £1,100,000. The results was a loss of £782,154 on the year's operations.

Nevertheless good progress was made with commissioning plant and connecting new consumers. Approval was also obtained from Parliament for six schemes with a combined capacity of 11,450 kW and an estimated annual output of 66·15 million kilowatt-hours. About 91 per cent. of the electricity sent out by the Board's stations was used to supply consumers in its own area. These now number over 338,000, of whom 16,000-odd were connected during the year covered by the report. Of these, 2,995 were farmers and crofters in the more isolated parts.

Of future schemes, surveys are well advanced on the River Farrar in Glen Strathfarrar, on the River Beauly in the Kilmorack Gorge and on the River Awe, and it is hoped to publish constructional schemes for these projects during the present year. Investigations continued into schemes for using the water of the River Tay at Kenmore and Grandtully, the Upper Finhorn and Monadhliath Mountains and the River Nevis. A scheme to build a dam across Loch Laidon to regulate the flood waters from the Moor of Rannoch is also being examined and preliminary surveys of the River Snizort in Skye are being carried out to find a supplement for the electricity supply of the island, which was affected by the drought. Sites for pumped storage are being surveyed at Cruachan (Loch Awe), Burn of Mar (Balmaha) and Loch Sloy with a view to using them to provide power at peak periods.

Although the drought adversely affected output, the dry weather greatly helped progress on the new works. As a result, over 24 miles of tunnel were driven during the year, bringing the total up to 110 miles, with another 30 miles in hand. Dam construction was facilitated for the same reason, although another favourable factor was that there was no shortage of cement. But fly ash was used at the Lednoch dam near Comrie and 16,000 cubic yards of this kind of concrete were placed by the end of the year.

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Challenge from Esso

It is only just over four months since the first large-scale synthetic rubber plans were announced for this country. Back in December, the International Synthetic Rubber Company was formed by the leading rubber companies to make initially 50,000 tons of G.R-S (general rubber-

The new lighting showroom of Philips Electrical Limited in London.

substitute) year as from 1958. This figure compares with 150,000 tons of natural rubber used at present here by the tyre industry. Some of the butadiene for this project comes from Grangemouth in Scotland.

Last week, the Esso Petroleum Company Limited, announced that it is preparing to erect a new butadiene plant at Fawley which will feed butadiene into a new £5 million synthetic rubber factory to be built nearby by the International Synthetic Rubber Company. Thus the Esso butadiene will be very well placed economically for the new synthetic rubber plant; presumably this is the meaning of Esso's reference in its announcement to supplying butadiene "at the right price." It is indeed beginning to look as though there may be more butadiene than the new synthetic rubber industry can at first cope with. This has a touch of irony about it for it is the production of G.R-S. in this country which creates the demand for butadiene.

So far as Esso is concerned, the butadiene project is part of a £9 million investment venture into petroleum chemicals—a venture which is also a challenge to the rest of the petroleum chemicals industry.

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Can You See?

"I never saw the step in the shadow," "the reflection dazzled me": two sentences often heard, and both arising from a single fault—bad lighting. Not for nothing have codes and regulations for industrial lighting been laid down and many a factory manager can report improvements in morale and output as a result of better lighting, and usually a drop in minor accidents as well. Where fine work is being done over long periods, careful attention must be paid to the lighting or the result will be fatigue, strain and decreasing output.

The importance of these matters is again brought to the fore by the opening of a new showroom by Philips Electrical Limited in Shaftesbury-avenue, London, W.C.2.

Here, in addition to a display of other products of the firm, the various types of lighting now available may be seen. Panels have been arranged to show how the combination of different shades of fluorescent tube can give different colour renderings of the same object, thereby reminding those concerned that mere brilliance is not enough—quality is required as well. Shadows can be avoided by concealed or diffused light but even more important is cleanliness—the loss of light due to a dirty globe, or loss in the reflection from a dirty wall, is one of the major causes of inefficiency in an installation. Indeed figures have been quoted to show that in some cases as much as one-third of the light has been lost by the accumulation of dust during only one month, the first after cleaning. It is an interesting fact, and one not widely appreciated, that the major loss due to the accumulation of dust occurs in the period immediately after cleaning, and losses increase at a much lower rate as time goes on.

Advice on lighting is now available to builders, architects and works managers from many sources, and though it may require a certain amount of forethought in planning, good lighting costs little to run (it may cost less than bad) and can mean much in improved efficiency and reduced fatigue.

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British Enterprise in Germany

The sales to Germany of glass pipe-line and industrial plant by Q.V.F. Limited, Stone, Staffordshire, have increased so rapidly during the past few years that the firm has found it advisable to establish a subsidiary company in that country with headquarters and works at Wiesbaden. This venture is the more worthy of record since before the war Germany had a virtual monopoly of industrial glassware manufacture. The company was, however, encouraged to take this step both by the rising export trade and the success of their display at the Achema Exhibition in Frankfurt last year. On that occasion, in fact, great interest was shown in Q.V.F's plant and products and several large orders were received. Although the Wiesbaden unit will be primarily a sales organisation—the bulk of the material being produced here—sufficient British machinery has been installed to make those parts which are necessary to connect English standard material to that already in existence. It will also provide a quick and easy repair organisation to be established and prompt service to be given on "specials" and designs peculiar to the German market. The first consignment of glassware and basic materials has now reached Wiesbaden.

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A Bottleneck on the Road

Among the evils of Britain's road system are the bottlenecks—small bridges, narrow roadways, complex road junctions—that impede traffic along otherwise not unreasonable routes. Bottlenecks, however, have the advantage that they are localised: alterations affect nothing outside the adjacent property, the work can be undertaken by one contractor, usually within the clauses of a single tender, the cost is relatively small, and each job can be tackled independently, either a number simultaneously or in succession.

High in the list for the worst bottleneck is Markyate on the London-Birmingham trunk road—the A5 route—where the kerbs are only 16 ft. apart at one point and where for half a mile there is only 25 ft. between facing buildings. It is one of the few places where a 15 m.p.h. speed limit exists. After 40 years of talking about a by-pass, work was begun last December on a new 30 ft. carriageway and a footway skirting the village. When the work was started the Ministry of Transport stated that it would take 12 months; this period has now been extended to 18 months. It will be June, 1957, before 1¼ miles of concrete road can be completed. How long will the 80,000 cub. yd. of excavation take? Having cut down to the sub-grade, the quicker the pavement is laid the better. The amount of concrete is negligible. There are no more time-wasting legal problems left to resolve. The labour force required for such a job is not large, neither need it be a particularly skilled force. Reinforcing bars—a shortage of which is preventing the commencement of many road schemes—are not holding up work at Markyate because a plain-concrete slab is to be laid. It would be more economical in labour and cheaper in cost to do the job quickly. But the work is being allowed to drag out twice as long as it should.

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Mr. Malenkov's Tour

It is curious that at a Press conference held by a technical delegation only one question of a technical nature should be asked. But it is less curious when one realises that the leader of the delegation in question was a former first minister of the Soviet Union. We do not regret the warmth with which the delegation was received, but had he chosen some other occasion to visit us the technical character of his delegation might have been more likely to emerge.

Still, one technical question was put, and the answer we received was to the point. Asked about Soviet atomic power station plans and the type of reactors to be used, Mr. D. G. Zhimerin, first deputy chairman of the State Planning Commission, replied that by 1960 some 2·5 million kW capacity of atomic plant would be installed. Some indication of corresponding British efforts is given by the White Paper statement that by 1965 the Central Electricity Authority would have some 12 stations in operation with a total capacity of up to 2 million kW. The reactors used in the Soviet stations would be of pressurised-water, heavy-water and gas-cooled design. The inclusion of the gas-cooled reactor may suggest an approach to the British view, and the extent of the whole scheme should mean either that coal is in short supply, which is unlikely, or that nuclear fuels are abundant.

Other leads were given from time to time during the tour by Mr. Malenkov, but it would be unwise to assume that what impressed him here was necessarily lacking in the Soviet Union. Some of the points on which he remarked with approval were the speed with which Calder Hall had been built (3 years); the overall grid system in Britain; "the rational placing and proper use of staffs, resulting in good indices for the number of personnel per unit of installed capacity"; the unit system of power-station construction, which he said was employed in the U.S.S.R.; and the cleanliness of power stations and their associated canteens, workshops and other premises—according to the British steel delegation which visited Russia, workshop cleanliness was also highly regarded in the Soviet Union. He was less impressed when told that Donington power station—which is to be the largest in Europe—was three months behind schedule, and observed that in Russia rivalry between construction and assembly men was used to stimulate progress; he also seemed surprised that the resident engineer in charge of erecting the boilers did not receive a bonus for early completion.

In a discussion with Mr. J. Eccles, deputy chairman (operations) of the C.E.A., Mr. Malenkov declared that it was wrong to permit engineers to reduce frequency slightly in order to avoid overloading at peak periods as British power stations did, since this also brought a drop in the capacity of the enterprises using the supply. Bonus awards in Russia depended on the ability of the engineer to maintain power, and a fall in frequency was regarded as a breakdown; in areas where plant was short, the consumer was cut off when overload appeared imminent. Mr. Eccles said that the C.E.A. allowed frequency to drop by only 3 per cent. and then shed load; it was better to keep supplies going at reduced frequency than cut people off.

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A Competitor for the Gas Turbine?

An announcement by Associated Engineering Limited that they have entered into agreement with Alan Muntz and Company, Limited, for the manufacture of the Pescara free-piston gas generator in this country focusses attention on the growth of this comparative newcomer among prime movers. The generators, or gasifiers as they are sometimes called, will be manufactured by a new company to be known as the Free Piston Engine Company, Limited, which will have its headquarters at the Wolverhampton works of Henry Meadows and Company, Limited.

The free-piston gas generator is a special application of the free-piston engine of which earlier examples were Otto and Langen's gas engine of 1867, and also the Humphrey pump. Of recent years air-compressors have been made using this principle. The purpose of the gasifier is to produce a large quantity of gas under high pressure and comparatively low temperature. This can then be used to drive a turbine. The free piston gasifier in its present form, acting in conjunction with a turbine, has attained an efficiency almost equal to that of a Diesel engine, and offers much greater flexibility.

It may be said that the gasifier takes the place of the combustion chamber of a gas-turbine set, and indeed it has this function. The great advantage is that the gas is produced at pressures up to about 1,000 lb. per square inch and at temperatures so low that ordinary steels can be used for the turbine blading instead of the special alloys that the high temperature of the conventional gas turbine requires. The great advance in the design of free-piston plant has been since the war, particularly in France where 23 ships have been equipped with this type of power plant, 12 electrical generating sets the

largest of which is a 6 MW plant at Cherbourg, and a 1,000 h.p. locomotive which has run on regular passenger service for more than two years.

Although there is still room for development, the free-piston gas generator-turbine set has already proved itself reliable in practice, and a specific fuel consumption of 0·38 lb. per s.h.p.-hr. compares well with that of a Diesel engine and is something like half that of a gas turbine. It has also all the advantages of the latter in freedom from vibration. A free-piston set is being installed in a Liberty ship which will increase the shaft-horse-power from 2,500 to 6,000 with a simultaneous reduction in weight from 463·8 tons to 385·4 tons as compared to the existing reciprocating machinery—another big advantage of the free-piston equipment.

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Keeping up with Atomic Energy

Developments in the field of atomic energy proceed so rapidly that in a few weeks the overall picture becomes noticeably changed. We have endeavoured in the past to keep our readers fully informed of these advances, and to this end have covered in considerable detail the Geneva Conference on the Peaceful Uses of Atomic Energy and the proceedings of the British Nuclear Energy Conference, besides publishing analyses such as the article "Power Reactor Projects Throughout the World," and various other specialist contributions. However, during our recent period of suspended animation, we have naturally been unable to keep up to date, and for that reason we are publishing in this issue a survey of atomic-energy events during the last two months. A second review covering products and techniques using nuclear principles which have been announced by companies during the period will appear in a subsequent issue.

But the scope of atomic energy is so great that there is still ample room for more detailed coverage, and we are pleased to note that a new monthly journal dealing exclusively with the subject has been launched this week. *Nuclear Engineering*, which is likely to be one of several papers to enter this field, is edited by Mr. E. N. Shaw, formerly of Harwell, and published by Temple Press Limited. It is designed primarily for engineers and technicians, though the publishers hope also to interest scientists and industrialists, and it is intended to be "an international journal with a pro-British bias."

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A Striking Electrical Display

The fifth Electrical Engineers Exhibition, organised by the Association of Supervising Electrical Engineers and held at Earls Court, London, last month, provided a striking illustration of what is being done by manufacturers to facilitate the increasing use of electricity in many fields. Over 300 exhibitors displayed some 25,000 products. The stands were almost without exception well arranged, and the fact that the lay public were not admitted seemed to act as a stimulus to the attendants. There was none of that lassitude about which there have been complaints at other exhibitions.

The Association state that there were over 52,000 visitors, an increase of 10,000 on the previous year; 500 visitors came from 55 countries oversea. Before the turnstiles closed 50 of the exhibitors had booked space in next year's exhibition, which is to be held from April 9 to 13—the week before Easter as it was this year. Switchgear and control apparatus were prominent in the exhibition. The exhibits in this section ranged from all but the very largest to the smallest apparatus; and it is encouraging to record the presence of a number of new and small firms such as are not usually represented. This is, of course, a natural outcome of the increasing use of electricity, which is worth stressing since the installation of new generating plant inevitably leads to the use of a great variety of equipment and apparatus. A feature of the switchgear and control apparatus was the increasing attention which is being paid to simple operation, easy maintenance and safety. The same is true of the motor section, although here there is not the same scope for improvement. The Association are to be congratulated on the success of their venture

Sir Ben Lockspeiser, K.C.B., M.I.Mech.E., F.R.Ae.S., F.R.S.

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Sir Ben Lockspeiser and T.I. Limited

The ranks of top-flight engineers on the boards of industrial companies have always been regrettably thin, though of recent years several heads of Civil Service departments have retired and then put their experience at the disposal of private companies. The appointment of Sir Ben Lockspeiser, until recently Secretary of the Department of Scientific and Industrial Research, to the board of Tube Investments Limited is an outstanding example of this trend.

Sir Ben took a First at Cambridge just before the first World War, and after being invalided out of the army in 1916 was posted to the Admiralty Steel Laboratory as a scientific assistant, at that time the lowest grade in the scientific Civil Service. In 1920 he moved to Farnborough and for the next 25 years undertook research in various branches of aeronautics, ultimately as the director general of scientific research at the war-time Ministry of Aircraft Production. The end of the last war saw his responsibilities widen for, as chief scientist at the Ministry of Supply, he took charge of research over the whole range of the Ministry's activities except atomic energy. In February, 1949, the man who had begun on the lowest rung of the scientific Civil Service was appointed to the most important executive post in Government science—Secretary of D.S.I.R. Sir Ben is a man whose horizon has never been limited by his science. A gifted amateur musician—he plays the piano and the 'cello—he was for some time the conductor of the R.A.E. orchestra.

But if Sir Ben's view is wide so are the interests of Tube Investments: a group of 40-odd companies making products which concern the whole gamut of the engineering industry. And behind the factories is the group's research organisation, with remarkably diverse equipment, centred on Hinxton Hall near Cambridge.

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Getting into Canada

Getting into the Canadian market has proved too much, with a few exceptions, to all but the largest British companies. There is in Canada a rapidly expanding demand for goods and products of all kinds, but small firms are faced with the expense of sound market research on which no immediate return can be expected.

To help suppliers to the gas and oil industries, and particularly with an eye on the growth of the natural gas industry in Canada, a new company has been established—Gas and Oil Equipment Distributors, Limited. Under the guidance of Major J. N. Watson the first objects will be to become incorporated as a limited company in Canada and to secure a sales force of Canadians who possess the requisite technical knowledge and contacts. A Canadian head office is to be opened in May from which sales and servicing can be directed. Where British goods can be sold through existing Canadian companies, such facilities will be used to the full. But the main object will be provision of sales offices, warehouses and service depots under the company's own name.

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Government Research

The Government have published the interim report of the committee under the chairmanship of Sir Harry Jephcott on which is based the Bill introduced into the House of Lords for the re-organisation of D.S.I.R. It is highly critical of the present direction from the centre of the scientific effort at the research stations; but the final report, which no doubt contains more criticism of particular stations as well as the confidential evidence on which it is based, will not be published.

The Government have accepted the committee's recommendations, of which the main one is that the present advisory council should be replaced by an executive council, which would be approved by, and be responsible to, the Minister and to whom the Secretary, who will continue to be a Civil Servant, will be responsible. The committee, for some reason which they do not explain, accepted that the Department should continue to receive its money through a normal Parliamentary Vote and not a grant-in-aid, the same way as the Medical and Agricultural Research Councils, although they would have preferred that arrangement. The grant-in-aid method would have allowed a greater degree of flexibility in arranging programmes and in payment of staff. The proposed arrangement with a part-time executive council responsible to the Lord President of the Council as the Minister concerned is unusual, rather similar to that for the national museums.

The composition of the council and, in particular, the selection of the chairman, will be of the greatest importance if it is to fulfil the manifold duties of ensuring the correct allocation of the by no means large sum of money which must be divided between pure and applied research and post-graduate instruction in science and technology, and between D.S.I.R's own stations, industrial and research associations and the universities and technical colleges. At least half the members should be scientific industrialists, preferably with experience of the direction of a large research department and, in view of the importance of the problem of getting new technological developments accepted on the shop floor, one should be a prominent trade unionist.

The report has disclosed another part of the nation's scientific effort where the familiar story of too much started and not enough completed or stopped has to be told again. Not only does this result in diffuse programmes and work of uneven quality, but it is wasteful of our scarcest resource—scientific manpower.

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THE HON. J. K. WEIR has relinquished his position as joint managing director, G. and J. Weir Ltd., Cathcart, Glasgow, S.4, to enable him to devote his whole time as chairman of the Weir Group of Companies. MR. J. RUSSELL LANG has been appointed sole managing director of G. and J. Weir Ltd., and SIR CHARLES CONNELL, M.A., has been elected an additional director of the firm.

S RESSES IN A CIRCULAR RING

NALYTICAL SOLUTIONS COMPARED WITH PHOTOELASTIC EVIDENCE

By E. R. Leeman, M.SC.(ENG.), A.M.I.MECH.E.*

A continuous plane ring, subjected to a single diametral tension or compression load in its own plane, represents a problem in stress analysis of relative simplicity, provided it is assumed that plane sections remain plane and that the cross-sectional dimensions of the ring are small compared with the mean radius. Results so obtained are sufficiently accurate for practical design purposes. When these assumptions are not made, and a mathematically exact solution is required, the problem becomes one of some complexity. Exact solutions have, nevertheless, been published for plane rings (i.e., those of rectangular section), and, in the following review, these are examined in relation to some results obtained from a photoelastic study. For rings of any shaped cross-section, an exact solution, applying the theory of elasticity, would seem almost impossible, but approximate solutions have been obtained and, again are sufficiently reliable for practical design problems.

ANALYTICAL SOLUTIONS

(a) Filon's determination of the Stresses in a Circular Ring.

The general form of the solution for the stresses in a plate bounded by two concentric circles was first outlined by A. Timpe.[1] He obtained the general form of the stress function. From this Filon[2] worked out explicitly the solution for the general case under any given edge stresses and, among others, the solution for the particular case of a ring subjected to diametrically opposite tensile forces applied to the inner boundary.

* Senior Research Officer, National Mechanical Engineering Research Institute, Pretoria. Formerly of the University of Natal, where this work was conducted.

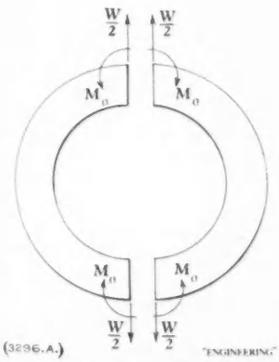

Fig. 1 Filon's method of finding the stresses in a circular ring. The ring is divided in half along the load-line diameter and the stresses due to ½W and M_0 are calculated.

(b) Method of Dislocations.

Inglis[3] indicated that the dislocation solutions suggested by Love would give the stresses in an incomplete ring subjected to given forces and couples applied to its end sections, and "that, by piecing together such solutions good approximations to the stresses existing in curved bars and links might be obtained." Filon applied these principles to a ring under diametral tension applied to its inside boundary, and, in fact, verified that the stresses derived thereby agreed very closely indeed with those of his exact solution, especially so at angular distances of more than 45 deg. beyond the loading point. He divided the ring into two equal half rings along the load-line diameter, applied couples and shears as shown in Fig. 1, calculated the stresses due to ½W and M_0 using Golovin's solutions[10] and combined them to obtain the stresses in the full ring.

W represents the tensile load on the complete ring and Filon obtained M_0 from the exact analysis as:

$$M_0 = \frac{W b}{\pi}\left\{\frac{1}{2} - \frac{1 - \log_e \frac{1}{k}}{\frac{1}{k^2}}\right\} \quad (1)$$

where $k = \frac{a}{b} = \frac{\text{Outside radius}}{\text{Inside radius}}$.

If the ring be subjected to a diametral compressive load W applied to the outside boundary, then the shears and moments will act in an opposite sense to that shown in Fig. 1, and the value of M_0, applying Filon's solution, is

$$M_0 = \frac{W a}{\pi}\left\{\frac{1}{2} - \frac{\log_e \frac{1}{k}}{k^2 - 1}\right\} \quad . \quad (2)$$

(c) Timoshenko's Treatment of a Ring Subjected to Diametral Compression.

Timoshenko[5, 9] combined Love's solution for a circular disc subjected to a diametral compression and Timpe's for a circular ring where the inner rim was subjected to normal and tangential tensions, to obtain the solution for a ring in diametral compression. This is illustrated in Fig. 2.

(d) Alternative "Dislocation" Treatment.

The value of the moment of the couple given by equation (1) is clearly dependent on the proportions of the ring, in consequence of the factor k. From strain energy and other considerations, it can be shown that for a ring whose cross-sectional dimensions are small compared with the mean radius of curvature R

$$M_0 = \frac{W R}{\pi} = \frac{1}{2\pi} W (a + b)$$
$$= 0{\cdot}3183\, W R = \frac{W b}{\pi}\frac{(k+1)}{2} \quad . \quad (3)$$

If this value of M_0 is used instead of that given by (1) for the ring in tension, a solution is obtained which will only approximate to the truth if equation (1) is correct. Filon has shown the divergence for various values of k. At $k = 1$ there is no divergence; at $k = 2$ (1) is about 5 per cent. lower than (3); at $k = 2{\cdot}5$ about 10 per cent. lower; at $k = 10$ about 50 per cent. lower. The divergence has also been calculated between (2) and (3) and the range of divergence is much less. For $k = 1$ there is again no divergence; at $k = 2$ (2) is about 2½ per cent. lower than (3); at $k = 2{\cdot}5$ about 2¾ per cent. lower and, at $k = 10$ nearly 5 per cent. lower. Equation (3) is therefore a better approximation for rings in compression, while for rings in tension it is only good for values of k less than 2. In this treatment, the stress distribution along a horizontal diameter will be the same for a ring in tension as for a ring in compression, except for a difference in the algebraic signs.

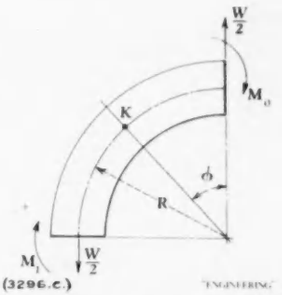

Fig. 3 Using the method of superposition, one quadrant of the ring may be considered to be in equilibrium under the loads and couples shown.

(e) Stresses along a Horizontal Diameter Using a Superposition Method.

One quadrant of the ring may be considered to be in equilibrium under the loads and couples shown in Fig. 3. Taking moments about K, $\frac{1}{2} W R \sin\phi - M_0 = M_1 - \frac{1}{2} W R (1 - \sin\phi)$, from which $M_1 = \frac{1}{2} W R - M_0$. Now M_0 may be assumed from either (1) or (3) above for the tension case, or (2) or (3) for the compression case. Using (1)

$$M_1 = \frac{W b}{2}\left\{\frac{2}{\pi}\frac{\log_e \frac{1}{k}}{1 - \frac{1}{k^2}} + \frac{k}{2} + 0{\cdot}1817\right\} \quad . \quad (4)$$

Using (3)

$$M_1 = 0{\cdot}1817\, W \tfrac{1}{2}(a + b) = 0{\cdot}1817\, W R. \quad (5)$$

At the horizontal section, therefore, it may be assumed that the stresses present are due to a moment M_1 calculated from Golovin's solution, and a normal tensile stress due to ½W acting uniformly across the section.

(f) Morley's Application of the Winkler-Bach Theory.

Morley[12] applied the principle used in (e), but used the Winkler-Bach instead of Golovin's theory to calculate the bending stresses at the intrados and extrados due to M_1. He suggested the following modified form of M_0:

$$M_0 = 0{\cdot}3183\, W R \left(\frac{A}{A'}\right)$$

where A = area of cross section, and A′ = first derived area of the section. For a rectangular section

$$M_0 = \frac{W b}{\pi}\left\{\frac{k-1}{\log_e k}\right\} \quad . \quad . \quad (6)$$

This is never greater than (3) and so will give

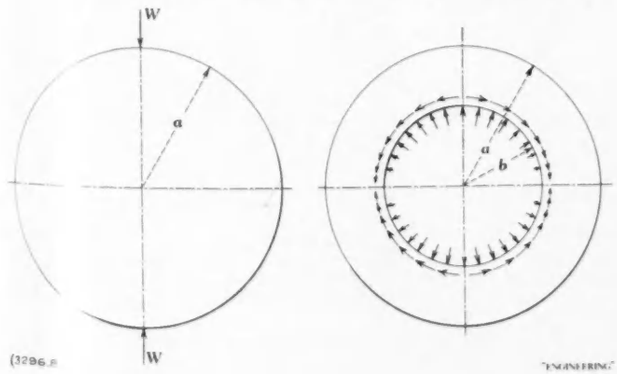

Fig. 2 Timoshenko's solution for the stresses in a circular ring is found by a combination of Love's solution for a circular disc subjected to a diametral compression (left), and Timpe's for a circular ring whose inner rim was subjected to normal and tangential tension (right).

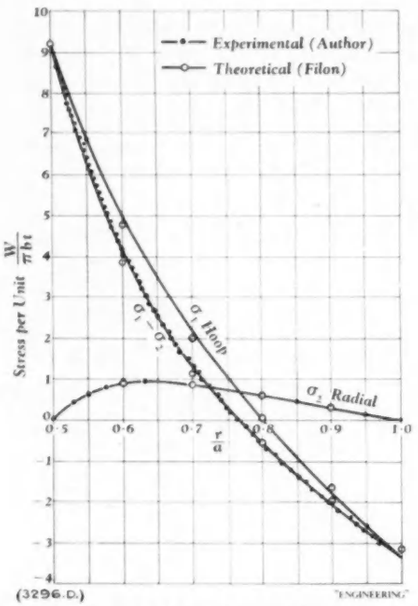

Fig. 4 The variation of stresses along the horizontal diameter of a circular ring (k = 2) subjected to a vertical diametral tension applied on the inner boundary.

values of M_0 tending to agreement with (1) and (2).

(*g*) *Andrews-Pearson Theory.*

This yields a refinement of the Winkler-Bach formula. The resultant stresses were calculated in a manner similar to that in (*e*), with the exception that the bending stress due to M_1 was obtained from a formula derived by Andrews and Pearson. From practical considerations this formula is not so convenient to use as that of Winkler-Bach.

COMPARISON OF STRESSES OBTAINED BY VARIOUS ANALYSES

(i) *Variation of Stresses along a Horizontal Diameter where the Ring is Subjected to a Vertical Diametral Tension or Compression; k = 2.*

The stresses at various values of $\frac{r}{a}$ are expressed per unit $\frac{W}{\pi b t}$ where W is the load, *b* the inside radius, *t* the ring thickness, *a* outside radius and *r* the radius at which the stresses are calculated. $\frac{a}{b} = k$. The stresses according to the different theories are as follow:—

(*a*) *Filon's Exact Analysis.* (*Ring in Tension, Loads Applied on Inner Boundary.*)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	0	0·8952	0·8939	0·6366	0·3189	0
Hoop stress	9·1900	4·7235	2·0258	0·0505	−1·6055	−3·1145

(*b*) *Method of Dislocations.* (*Ring in Tension, Loads Applied on Inner Boundary.*)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	0	0·8957	0·8944	0·6367	0·3184	0
Hoop stress	9·1913	4·7235	2·0251	0·051	−1·6052	−3·1153

(*c*) *Method of Dislocations.* (*Ring in Compression, Loads Applied on Outer Boundary.*)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Hoop stress	−8·892	−4·590	−2·006	−0·113	+1·473	+2·928

(*d*) *Timoshenko's Analysis.* (*Ring in Compression, Loads Applied on Outer Boundary.*)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Hoop stress	−8·942	−4·610	−2·012	−0·113	+1·477	+2·940*

* In Timoshenko's "Theory of Elasticity" this figure is given as 2·610. A check by the author, however, seems to indicate that this should read 2·940.

(*e*) *Alternative Dislocation Method.* (*Ring in Tension/Compression, Loads Applied on Either Boundary.*)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	0	±0·825	±0·815	±0·571	±0·283	0
Hoop stress	±8·598	±4·458	±1·988	±0·178	∓1·343	∓2·745

(*f*) *Superposition Method.* (*Ring in Tension/Compression, Loads Applied on Either Boundary Using* M_1 *from Equation* 5).

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	0	±0·784	±0·910	±0·730	±0·401	0
Hoop stress	±8·218	±4·577	±2·034	±0·124	∓1·393	∓2·642

(*g*) *Application of Winkler-Bach Theory.* (*Ring in Tension, Loads Applied on Either Boundary Using* M_1 *from Equation* 5.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	0	0	0	0	0	0
Hoop stress	+8·185	+4·592	+2·026	+0·102	−1·395	−2·593

(*h*) *Application of Winkler-Bach Theory.* (*Ring in Tension, Load Applied on Inner Boundary, Using* M_1 *from Equation* 4.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	0	0	0	0	0	0
Hoop stress	+8·770	+4·860	+2·067	−0·028	−1·649	−2·961

DISCUSSION OF RESULTS: PHOTOELASTIC VERIFICATION

The fact that the results given by Filon's exact analysis and the method of dislocations are in such close agreement at the horizontal section (which is relatively remote from the point of application of the load) seem to justify the claim of exactness for these theories. The agreement in the results for a ring in compression, by Timoshenko's theory and by the method of dislocations, is also remarkable, remembering Timoshenko's admission that there might be an error of about ½ per cent. in his figures. Frocht[4] and Horger[5,6] have confirmed Timoshenko's analysis for various values of *k* using photoelasticity.

A photoelastic investigation was conducted by

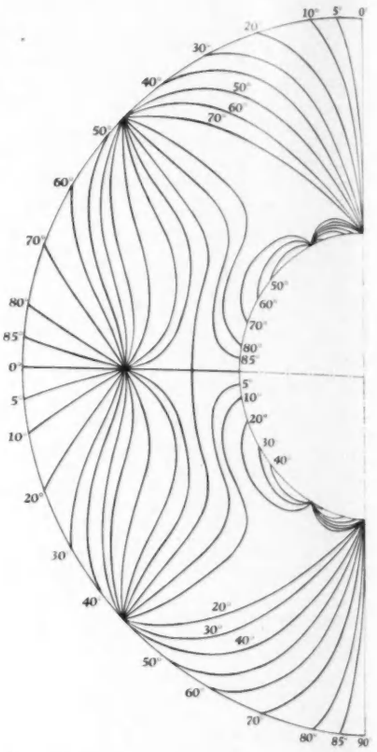

Fig. 6 A typical isoclinic pattern for a ring in vertical diametral tension, the load being applied on the inner boundary. Only half the pattern is shown.

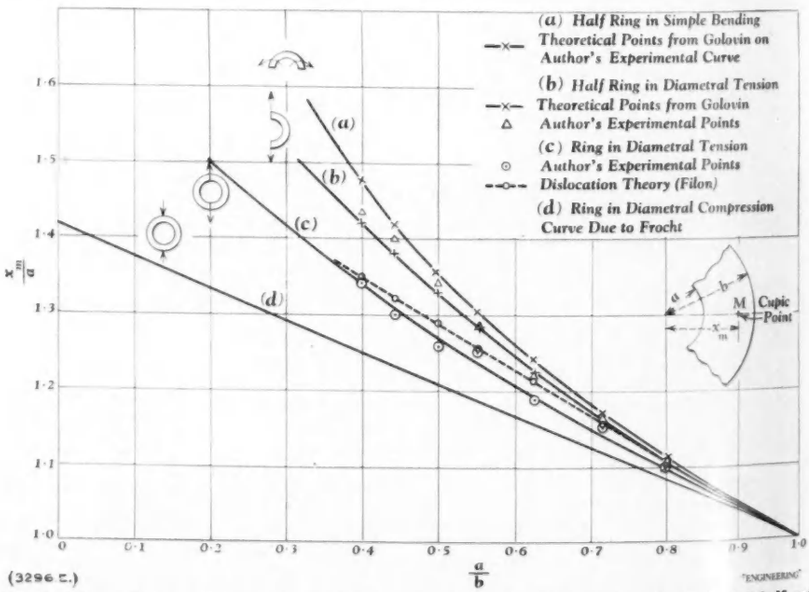

Fig. 5 The positions of the cupic points on the horizontal sections of variously loaded half and full rings.

the author on a ring where $k = 2$ and subjected to a vertical diametral tension, in order to verify Filon's figures. The stresses along a horizontal diameter were examined, and Fig. 4 shows that the agreement obtained in this case was very good. The variation in the difference of the principal stresses was obtained using Tardy's method. Similar tests were conducted on rings having other values of k and, in general, the agreement between the boundaries was good. Variations from Filon's theory which occurred at the extrados and intrados did not exceed 3 per cent. and may be attributed to experimental inaccuracy. A similar investigation conducted on half rings subjected to diametral tension also gave good agreement with Golovin's theory and the ratio $\frac{\text{Stress at Intrados}}{\text{Stress at Extrados}}$, which equals k, was verified without difficulty.

The results given by the "approximate" methods (see (*e*), (*f*), (*g*) and (*h*)) are interesting, particularly those by the Winkler-Bach theory (see (*g*)). Here, an underestimate of over 10 per cent. in the intrados stress is involved. Where the more accurate expression for M_0 is used the underestimate is nearer 5 per cent. (see (*h*)). Fortunately, the practical design of such rings would not depend so much on the stresses at this section, since the maximum stresses are usually found to occur at the vertical diametral section.

Another point of interest is the position of the point of maximum radial stress, or, in photoelastic terms, the position of the cupic point. For half rings subjected to simple bending or diametral tension, the theoretical positions of these points for various values of k were obtained using Golovin's solutions[10] and are shown graphically in Fig. 5. Experimental curves from photoelastic tests on half rings subjected to simple bending and diametral tension are also drawn (A) and (B), and fit Golovin's theoretical points remarkably well. Curve (C) represents the experimental curve obtained for complete rings subjected to diametral tension and it lies fairly close to the points obtained by Filon's dislocation treatment. Curve (D) is Frocht's curve[11] obtained for rings which are in compression.

Fig. 6 is a typical isoclinic pattern from which one of the cupic point positions was determined. Fig. 7 is a typical fringe pattern obtained during these investigations.

(ii) *Variation of Stress Around the Extrados and Intrados.*

Fig. 8 shows typical polar curves representing the variation of stress around the extrados and intrados for a ring with $k = 2$. The theoretical curve drawn is from Filon's analysis. Agreement is good and large deviations only occur near the loading points where the model material was evidently in high local strain.

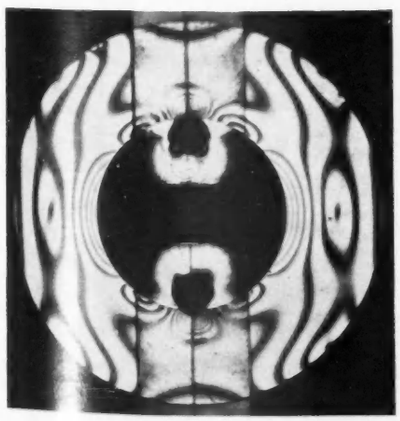

Fig. 7 Typical photoelastic fringe pattern of a ring in tension using perspex straining members (k = 2).

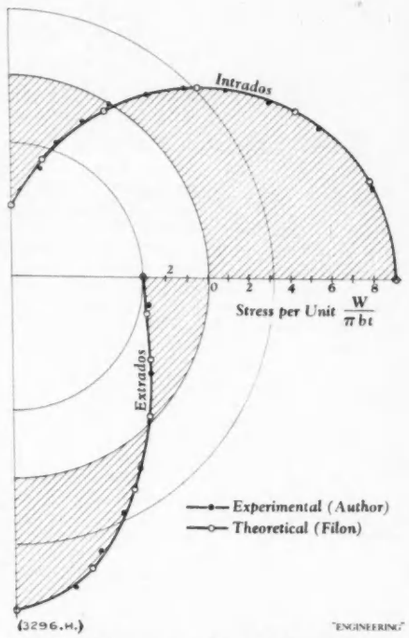

Fig. 8 Polar curves showing the variation of stress around the boundaries of a ring (k = 2) in tension.

(iii) *Variation of Stresses along a Vertical Diameter* ($k = 2$).

(*a*) Filon's Analysis. (Ring in tension, load applied on inner boundary.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	—	−10·1207	−4·5148	−2·2068	−0·8502	0
Hoop stress	−6·1955	−2·0209	+0·3060	+2·1874	+4·1271	+6·4082

(*b*) Method of Dislocations. (Ring in tension, load applied on inner boundary using M_0 from equation 1.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress	—	−1·3029	−1·5128	−1·2130	−1·6661	0
Hoop stress	−11·0450	−4·9949	−0·7714	+2·4057	+4·9256	+7·0028

(*c*) Timoshenko's Analysis. (Ring in compression, loads applied on outer boundary.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Hoop stress	+10·147	+4·002	+1·240	−0·594	−2·185	−3·788

(*d*) Method of Dislocations. (Ring in compression, loads applied on outer boundary using M_0 from equation 2.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Hoop stress	+11·343	+5·129	+0·790	−2·470	−5·058	−7·190

(*e*) Application of Winkler-Bach Method. (Ring in tension/compression, loads applied to either boundary using M_0 from equation 3.)

$\frac{r}{a}$	0·5	0·6	0·7	0·8	0·9	1·0
Radial stress ..	0	0	0	0	0	0
Hoop stress	∓11·586	∓5·293	∓0·798	±2·573	±5·196	±7·294

There is clearly a marked discrepancy between the figures given by the various theories at the vertical diameter. There are experimental difficulties involved in checking the stresses at this section in a ring subjected to a tensile load applied on the inner boundary, but by using perspex straining members it was possible to obtain some idea of the stresses here. From Fig. 7 it would appear that the perspex does not distort the ring fringe pattern materially. From Fig. 8, furthermore, the experimental stresses at the extrados would appear to agree fairly well with those obtained by Filon's theory. There are obvious difficulties in assessing the stresses at the point of application of load. From a practical design point of view the error involved in using the Winkler-Bach theory is not serious, because this theory over estimates the stresses at this point.

CONCLUSIONS

Within the limits of experimental error, the photoelastic experimental evidence clearly justifies the claim of exactness for Filon's theory for a ring in diametral tension. The remarkable theoretical agreement between Timoshenko's and Filon's figures for a ring in compression confirm the exactness of these solutions which were derived by different approaches. Unfortunately the application of these solutions in practical design work is difficult because of their complication. The simpler Winkler-Bach method, although less accurate, gives results which will be on the safe side.

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THERMOSTATICALLY CONTROLLED IGNITRONS

Philips Electrical Limited, Century House, Shaftesbury-avenue, London, W.C.2, are now manufacturing three patterns of thermostatically controlled ignitrons. This control enables protection to be given to the tube and associated equipment in case the water supply fails. It also results in a reduction in water consumption, an important point when it is difficult to obtain supplies free from pollution.

All three of the new ignitrons are of the single-anode mercury-tube type with jackets of stainless steel to minimise the effects of corrosion and igniters of high refractory material. They are designed for welder control on single-phase and three-phase circuits and have maximum ratings from 600 to 2,400 kVA at 250 to 600 volts root-mean-square.

They are normally connected in reverse parallel, when the first ignitron incorporates the water-saving thermostat, which closes at about 100 deg. F. and opens at about 80 deg. F. A protective thermostat mounted on the second ignitron opens at about 130 deg. F., interrupting the ignitor circuits or tripping the main circuit-breaker. The contactors on both thermostats are rated at 125 volts and 10 amperes or 250 volts and 8 amperes.

The Engineering Outlook—8

LOCOMOTIVES AND ROLLING STOCK

BRITISH BUILDERS WILL BE BUSY

The year 1955 was an eventful one for the locomotive and rolling stock industry. At home the first large contracts were announced in connection with the British Transport Commission's modernisation and expansion plan, while wagon manufacturers were able to look forward to increasing demand resulting from the expansion plans of the oil industry. News from abroad included two new world records in France, the introduction on some scale of turbo-Diesel locomotives and double-decked carriages in the United States and the announcement of large railway expansion plans by the U.S.S.R., Egypt, India and South Africa. British locomotive builders, however, experienced strong competition in foreign markets and a number of valuable orders were lost to competitors in Germany and Japan.

In the United Kingdom the main event was the placing of the first contracts by the British Transport Commission to implement their £1,200 million development plan. There was considerable speculation throughout the year as to the size of these initial contracts but in November, 1955, it was announced that contracts to the value of £10 million were to be placed covering 141 main-line locomotives and 30 power units. Of the 141 locomotives, 130 were to have Diesel-electric transmission and 11 Diesel-hydraulic. The scheme is described as a pilot plan to find out exactly how the varying designs prove themselves on the British railway system. Accordingly, the Commission spread their orders over as many companies as possible, and three main designs were specified:—Type A (800 to 1,000 h.p. for freight); Type B (1,000 to 1,250 h.p. for mixed working); and Type C (2,000 h.p. or over for main-line operation). The 30 power units are to be supplied for use in new locomotives built in British Railways' workshops. Delivery of the locomotives under the main contracts will start in 1957.

VALUE OF HOME MARKET

Over the whole period of the modernisation plan, that is to 1970, the B.T.C. may order some 2,500 main-line Diesel locomotives although this will be subject to variation as the plan develops. In terms of yearly contracts this should amount to around 170 locomotives a year and would effectively guarantee output of this type of locomotive until at least 1972. Last year production of Diesel locomotives for British Railways was estimated at about 115 units, compared with 54 in 1954. It is confidently expected that exports will also increase as world railway systems continue the large-scale switch to Diesel and electric traction which has been taking place in many countries during the last few years.

Manufacturers as well as overseas customers point out that opportunities to expand in the export market will be considerably enhanced when overseas buyers can see for themselves how the new locomotives perform on the British railway system. Quite often the reason for German and French success in the locomotive export market has been not so much price advantage as proved worth. The phrase, "Practice what you preach," has had a very real meaning to British Diesel locomotive manufacturers over the last two or three years.

Nevertheless export earnings continue to account for a high proportion of the total income of locomotive builders. Of a total output of some 760 Diesel locomotives produced last year, 391 went abroad and the value of exports (shown in Table I) increased by almost 50 per cent. While exports of Diesel locomotives continue to expand, however, manufacturers of steam locomotives have had to face extremely severe competition in a declining market, and as a consequence important contracts have been lost. Exports of steam locomotives declined by 36 per cent. in 1955 and for the first time were lower in value than exports of Diesel-type locomotives. It is likely that 1956 will see a further decline in exports of steam locomotives since competition is becoming more intense for the decreasing market for steam engines, demand for which is now mainly concentrated on relatively underdeveloped countries such as India and the Far East. To some extent the decline in exports must be attributed to the economic recovery of Japan, whose manufacturers are said to be quoting below costs of production in order to gain a footing in the international market for steam engines.

At any rate, British manufacturers were not very successful in competing against either Japan or Germany when contracts to the value of £60 million were placed for locomotives and rolling stock in connection with the 1955-56 Indian development plan. Of this total, only £4 million worth of contracts were awarded to British companies, a total which included orders for about 3,000 freight wagons and other equipment. British tenders were said to be 30 per cent. above the lowest quotation. Of the contracts awarded for steam engines, 151 orders amounting to over £2 million were placed with German firms, Japan secured 125, Austria 50, and Czechoslovakia and Hungary 40 orders each. The only contract placed with a British locomotive company was for 12 electric locomotives from the English Electric Company, Limited. No steam locomotives were ordered from United Kingdom manufacturers and British exports to India are likely to fall to a negligible figure when contracts almost completed at the present time are finished.

POSITION OF STEAM LOCOMOTIVES

In respect of other Commonwealth markets, some British companies manufacturing steam locomotives have been a little more fortunate. A large contract valued at £3 million for 35 locomotives was placed last year by the South African Railways with Beyer, Peacock and Company, Limited. This company has kept in the forefront of design and research, particularly in the field of large articulated locomotives, and since the beginning of 1955 have delivered to East Africa a number of a new class of Beyer-Garratt locomotives which are said to be the most powerful ever built for metre-gauge track. These orders however can be counted as an exception to the general rule and it may well be asked if there is any future at all for the steam engine?

It was suggested in ENGINEERING (June 17, 1955) that while the steam engine is declining it is by no means dead. This remark was made in connection with the introduction of Crosti boilers on British Railways, which seemed to hold out hope of substantially improved efficiency for the steam locomotive. There is no evidence, however, that the Crosti boiler, or any of the hundreds of ideas for improvement which have been put forward, will alter the accepted characteristics of the steam locomotive.

It is unlikely that any new system will check the growing trend to oil and electric traction. There are so many factors weighted against the steam engine, among which may be mentioned the smoke problem which has never been satisfactorily overcome, the growing shortage and increasing price of coal and the fact that the Diesel locomotive can be used much more intensively without recourse to long periods of idleness while refuelling. In some countries, however, oil-fired steam locomotives can show advantage over Diesels since they can use a cheaper fuel.

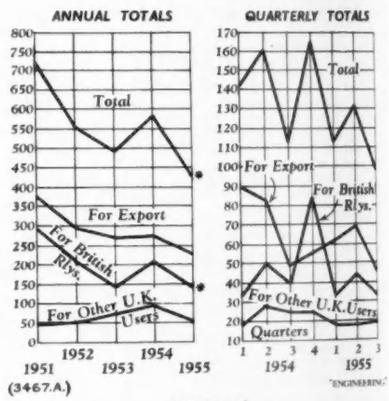
Exports of Diesel locomotive[s] rose sharply in 1955 and a number of valua[ble] orders were obtained for future delivery.

At the end of the year Met[ropolitan]-Vickers were building 40 Diesel locom[otives] for New South Wales, and in June, 19[55] this company started deliveries against the £4[½] million contract from Coras Iompair Eireann [for] the supply of 94 Diesel locomotives in the face of severe competition from the United States and continental countries. To August, 1955, the General Electric Company, Limited, had supplied equipment for 40 locomotives to South Africa while the English Electric Company had almost completed delivery of 60 3,600 h.p. locomotives to Spain. The latter company is now working on an order of 60 locomotives for South Africa.

Late last year the South African Minister of Transport, Mr. B. J. Schoeman, announced that the estimated capital requirements of South African Railways would amount to approximately £68 million during 1956-57. Tenders are to be called for during this year, firstly for Diesel-electric shunting engines to replace steam shunting engines at the bigger centres and secondly for 60 Diesel-electric main-line locomotives to be used in arid country where water shortage precludes the use of steam engines. The Dieselisation programme of South African Railways is in itself estimated to involve an expenditure of approximately £11 million. South Africa has always been a profitable market for British builders of steam locomotives and it will be interesting to see how Diesel-locomotive makers fare in this area.

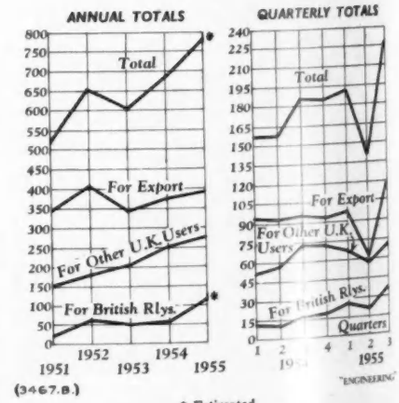
SOVIET PLAN

Behind the Iron Curtain, a 15 year electrification scheme is to be launched under the Soviet state plan this year. New Diesel-electric locomotives are under construction in the U.S.S.R., but it is improbable that all the demands made by the modernised Russian railway system



* Estimated.

British production of steam locomotives.



* Estimated.

Diesel locomotive production in Great Britain.

can be met within the next 15 years by domestic output, and it is possible that provided their export does not cut across the strategic list the British industry may secure orders for locomotives from this source.

South America has in the past been a traditional outlet for British locomotive manufacturers but German competition, which was always felt before the war, has lately tended to become even more intense. As a result of recently announced development plans there may well be a substantial increase in demand from South American countries, particularly Brazil and Venezuela. Both these countries and indeed most countries in South America have on their doorstep a great potential source of hydro-electric power in the Andes, and the future is likely to see a growing development of electric traction. Last year Krupps of Germany announced plans to set up an assembly plant in Sao Paulo and the Brazilian subsidiary of this company expects to start manufacturing Diesel-electric and steam locomotives 15 months after the 20 million dols. plant is completed, although political factors are at present holding back development. Production is estimated at 200 locomotives during the first five years of operation, rising to 100 a year thereafter. If the large British manufacturers of locomotives are to gain a satisfactory footing in this valuable South American market they might do well to consider following the German eagle to this Latin eyrie.

The performance of the new Diesel locomotives on British railways will be important from the view point of export orders. This country is a relative newcomer to the field of large-scale Diesel locomotive construction, and in some of the new locomotives at least part of the equipment has to be imported, while for others continental equipment is manufactured in this country under licence. All the 11 locomotives to be built by the North British Locomotive Company for the B.T.C. will have German M.A.N. engines and Voith transmissions. The Voith transmission, which is clutchless, relies for its ranges of speed on three hydraulic systems using the same number of torque converters. The power is transmitted to the axles by cardan shafts from the transmission, mounted on the locomotive frame. Another example of reliance on German design was the announcement in January, 1956, that three 2,000 h.p. locomotives as used on the German Federal Railways system are to be built at the Swindon works of British Railways. In this development arrangements have been made through the Brush group for the purchase of three sets of Maybach Diesel engines, while three sets of Mekydro hydraulic transmissions will be obtained from Germany. It has now been announced that J. Stone and Company (Deptford) Limited, have acquired the exclusive rights to manufacture and sell Mekydro power transmission in the United Kingdom.

DELTIC DIESEL

One important exception to dependence on German design is the use of Napier Deltic Diesel engines in the powerful new English Electric locomotive, the Deltic Diesel. This locomotive, which is described as the most powerful single-unit Diesel locomotive in the world, develops 3,300 h.p. and has a maximum tractive effort of 60,000 lb., the continuous tractive effort being estimated at 31,000 lb. at 33 m.p.h. The weight-to-power ratio of the Deltic Diesel, at 72 lb. per h.p. is claimed to be better than that of either the American Trainmaster (2,400 h.p., weight-to-power ratio of 104 lb. per h.p.), or the German Krass-Maffei (2,200 h.p., 85 lb. per h.p.). When tenders were invited for locomotives by the British Transport Commission the price of the Deltic at £120,000 was said to be the lowest in relation to h.p. of all the 13 locomotives put forward by the English Electric Company last year.

After three years of trial, British Railways last year eventually purchased the Fell Diesel-mechanical-transmission locomotive which is the first main-line engine to incorporate a mechanical transmission system. It has been stated by British Railways that an outstanding feature of this locomotive is the high draw-bar power-weight ratio which derives from the use of small high-speed engines instead of a single large one, and the high transmission efficiency achieved.

Table I.—United Kingdom: Exports of Locomotives

—	Quantities (tons)			Value (£1,000)		
	1953	1954	1955	1953	1954	1955
Complete Locomotives						
Gold Coast	22	491	525	7	334	355
Union of South Africa	6,544	15,055	1,883	1,928	6,259	904
Kenya	845	2,420	9,966	202	711	3,127
India	4,366	2,230	2,963	1,205	566	1,355
Ceylon	257	676	946	156	426	583
Australia	4,570	9,756	4,069	2,709	3,498	2,173
Anglo-Egyptian Sudan	64	4	n.i.	41	1	n.i.
Other Commonwealth Countries and Irish Republic	6,757	6,314	15,238	1,966	2,676	7,057
Spain	4,266	3,125	2,057	1,933	1,303	1,138
Angola	4	7	n.i.	1	2	n.i.
Egypt	60	21	n.i.	23	6	n.i.
Brazil	300	912	—	196	768	—
Argentine Republic	702	—	2	180	—	1,935
Other Foreign Countries	6,968	5,529	2,170	2,116	2,094	953
Steam Locomotives	22,755	32,149	22,548	6,228	11,035	7,001
Other types	12,970	14,360	17,271	6,435	7,586	10,646
Total	35,725	46,509	39,819	12,663	18,621	17,647

n.i. = not indicated separately.

Table II.—United Kingdom: Exports of Railcars, Carriages, Wagons and Parts*

—	Quantities (Tons)			Value (£1,000)		
	1953	1954	1955	1953	1954	1955
Railcars	2,902	2,849	1,190	1,282	1,521	1,013
Railway Carriages, complete	8,953	8,105	5,685	3,600	2,710	2,255
Wagons and Trucks complete	71,880	59,175	35,167	7,590	7,038	4,408
Parts of railway vehicles:*						
Axles, tyres and wheels	87,662	53,749	84,371	6,326	4,115	6,384
For railway carriages	2,316	3,066	1,823	1,041	1,429	1,044
For wagons and trucks	20,268	18,942	11,368	2,524	2,568	1,592
Other	24,869	19,253	16,658	7,563	6,314	6,110
Total	218,850	165,139	156,262	29,926	25,695	22,806

* = Including parts of locomotives.

ELECTRIC TRACTION

Further developments in the field of electric traction still tend to be cramped by the need to introduce electric locomotives which can pull goods trains without continuous braking. Discussion continued last year on the relative merits of alternating and direct-current motors. Much progress has been made in recent years in the design of motive power for 50 cycle traction, and where trains are relatively light and can be accelerated speedily, the 50 cycle system has been adopted by several railway administrations abroad. In Great Britain the decision to electrify on the 25kV alternating-current system—as described in last week's issue—was of fundamental importance to the future prosperity of British Railways.

Large-scale main-line electrification is dependent in this country on a reduction in generating costs which may possibly come about as a result of the development of atomic energy. For suburban passenger traffic, the high rate of acceleration associated with electric traction continues to warrant further extensions. The next big scheme in this direction will be the extension to Chelmsford and Southend of the Liverpool Street to Shenfield electrified line of the Eastern Region of British Railways, which was scheduled to be completed in 1957.

In the main, however, interest in electrical development had so far centred on other countries. In particular, of course, France was in the news last year with a new world rail speed record of 206 m.p.h. achieved with a six-axle locomotive developing 4,740 h.p. at 1,500 volts. It is estimated that by 1965 80 per cent. of the French railway system will be electrified.

Another important development abroad has been the growth of the gas-turbine locomotive in the United States. What was described as a "major breakthrough" in the railway industry was announced late last year when the Pacific Railroad agreed to buy 43 gas-turbine locomotives from the General Electric Company of America. This company think that an initial market may develop for up to 200 of these locomotives. In France the Régie Nationale des Usines Renault have for the past five years been working on the application of free-piston gas generators to driving Diesel locomotives and it was announced last April that the first turbo-Diesel locomotive in the world in which the turbine is propelled with a free-piston generator had been constructed. It is still, however, in the experimental stage.

ROLLING STOCK

In turning to consider developments in the field of rolling stock, it is interesting to note the resurgence of a type of unit which is not strictly a coach but cannot be called a locomotive in the usual sense of the word. This is the Diesel railcar. Some 35 of these were in use before the war on the old Great Western Railway, but their use did not become fully appreciated until quite recently. Up to September, 1955, there were still only 60 passenger-carrying Diesel railcars in operation on British Railways. It is estimated that by the spring of 1956 over 180 will be in use, and under the British Transport Commission's development plan 4,600 units are expected to be introduced by 1970.

There are many advantages claimed for this type of unit, which can if required be coupled to two or three coaches. Their ability to attract more passengers cannot be questioned and several practical examples of this have been in evidence over the last few months. For example, early in 1956 it was stated that in the first six days of operating seven 2-car units on the Bury to Bacup line of the London Midland Region, 23,000 passengers were carried, compared with about 8,000 in the same period last year, when the service was operated by steam. By quicker turn-round, these trains are said to provide 35 services daily compared with 19 when the line was steam operated. Diesel cars have a high acceleration rate, particularly suitable for short distances and suburban lines, and an additional advantage is that they use no fuel when not running.

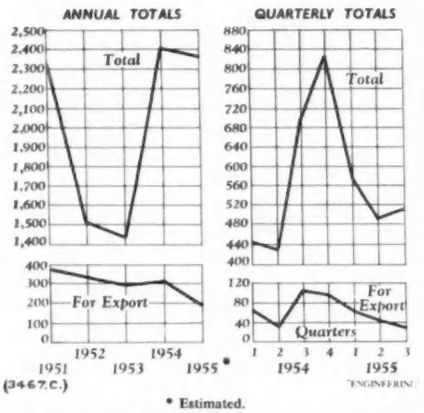
Manufacturers of coaching vehicles should benefit in the same way as locomotive builders from the modernisation plans of British Railways. In 1955, it was estimated that almost 2,400 coaching vehicles were produced (this figure includes Diesel railcars and rail motor-vehicles);

in March, 1955, the British Transport Commission placed contracts with British manufacturers for 207 new coaching vehicles and this rate of ordering must necessarily be accelerated in the future if modernisation plans are to be completed. Exports of this type of rolling stock, however, continued to decline. In 1951, 375 coaching vehicles were exported, while in 1955, it is doubtful whether the total reached 200. This was due largely to intensified overseas competition, very low prices being quoted in particular by Japan, Yugoslavia and Hungary. In addition British manufacturers have found difficulty in competing with the deferred payments offered by continental countries including Germany and Belgium, which has been an important factor in such markets as India, Greece and South America.

The decline in exports is not universal, however. In June, 1955, Metropolitan-Cammell secured an order for 349 railway coaches valued at £7·2 million for the South African Railways. Delivery is to take place between 1957 and 1958, and the order was gained in the face of strong competition from Holland, Germany, Switzerland, Czechoslovakia, Italy, France and Belgium.

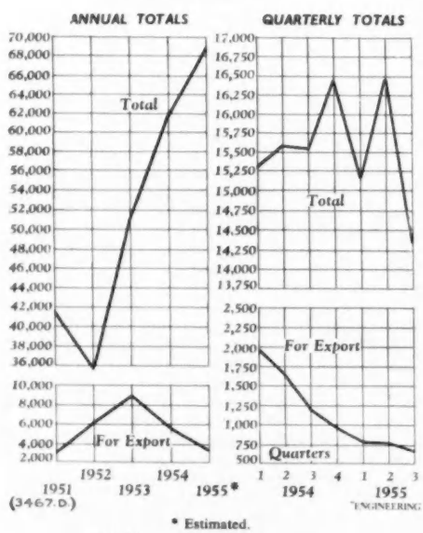
WAGONS

Manufacturers of wagons are suffering in the export market not through price, which is competitive, but through inability to offer satisfactory delivery dates, unavoidable insistence on a cost variations clause-cover, and refusal to accept what have been called penal terms and conditions. Inability to quote fixed prices is a symptom of the continuous inflation in labour and material costs. While wagon exports suffered last year, however, manufacturers of wagons are facing the future with a high degree of confidence, mainly as a result of the expansion programme of British Railways, though an additional factor is the huge expansion envisaged in oil consumption. This latter development must necessarily entail a sharp increase in the demand for rail tank cars in which the bulk of inland fuel oil supplies are carried. Owing to congestion on the roads it is expected that substantially the whole of the increased consumption of oil will be carried by rail. It has been estimated that under the proposed fuel-expansion programme the increase in the value of rail wagons bought by the oil industry may be about £200,000 a year for the next decade. Last year industry as a whole purchased rail wagons valued at about £700,000 and of these the oil industry probably accounted for about £150,000. Provided the steel and the necessary labour is forthcoming, the future for wagon manufacturers would appear promising.



* Estimated.

British production of coaching vehicles, including rail motor vehicles.



* Estimated.

British production of wagons.

INSTITUTION OF NAVAL ARCHITECTS SPRING MEETING

PRESIDENT RECEIVES NEW BADGE OF OFFICE

The Spring Meeting of the Institution of Naval Architects began on Tuesday, March 20, with an interesting ceremony, the presentation to the President of the Institution, Viscount Runciman of Doxford, O.B.E., A.F.C., D.C.L., of a Presidential badge bearing the Institution's coat of arms. In making the presentation on behalf of Vickers-Armstrongs Limited, Mr. E. L. Champness, M.B.E., M.Sc., said that members had been rather conscious of the fact that on ceremonial public occasions, at home and abroad, the President had lacked such a distinguishing emblem and had been obliged to appear, so to speak, "in a state of comparative undress."

The recent grant of arms to the Institution, he continued, afforded an opportunity to correct that omission and he sought permission, therefore, to present to the Institution a Presidential badge, on behalf of the shipbuilding and ship repairing interests of Vickers-Armstrongs Limited at Barrow, Walker, and Hebburn. Students of heraldry would have noted that the College of Arms had seen fit to have the supporters of the shield duly "roped proper," or, in their own phrase, "gorged with a Naval Crown with rope pendent"; so he felt that they were in order in thus ballasting their President. He added that the badge had been designed by Mr. L. C. Evetts, M.A., Master of Design at King's College, University of Durham, and had been executed by John Pinches (Medallists), Ltd., of London.

Lord Runciman, in accepting the gift, said that it was stated in the Thirty-Nine Articles that the insufficiency of the minister did not affect the validity of a sacrament. In that spirit he accepted, on behalf of the members, of himself, and of those who would succeed him in office over the years, the badge which Mr. Champness had presented on behalf of Vickers-Armstrongs, and which he would wear with pride so long as he was President. He then called on the Secretary of the Institution, Captain A. D. Duckworth, R.N., to present the Council's Report.

Annual Report

The Annual Report showed that the increase in the membership of the Institution, which has been proceeding steadily for a number of years, still continues, the total at the end of 1955 being 3,866, as against 3,728 at the end of the previous year. Except for the negligible reduction of 2 in the number of Students, all grades participated in the increase. The number of Associates (750) was exactly half of the number of Associate-Members (1,500). At the completion of the commemoration of William Froude, by the erection of a tablet at Chelston Cross, near Torquay (where his first ship-model tank formerly stood) and the publication of his collected papers (reviewed in ENGINEERING on page 149 of the issue of February 17), the Council found that they had still some money in hand from the funds subscribed for that purpose. They had decided, therefore, to institute a gold medal, to be known as the William Froude Medal, "to be awarded from time to time to any person who, in the opinion of the Council, has made some outstanding contribution to naval architecture and shipbuilding"; and to make the first award to Professor Sir Thomas H. Havelock, M.A., D.Sc., F.R.S., Honorary Member and an Associate Member of Council.

Election of Council and Officers

The ballot for the vacancies on the Council resulted in the election, as Vice-Presidents, of Mr. K. C. Barnaby, O.B.E., B.Sc., and Mr. J. Ramsay Gebbie, C.B.E., D.Sc.; as Members of Council, of Mr. John Baird, B.Sc., Mr. John Brown, B.Sc., Dr. T. W. F. Brown, Mr. A. Hunter, Mr. J. A. Milne, C.B.E., Mr. A. R. Mitchell, M.B.E., M.C., Mr. Henry Robb, Mr. J. Robson, M.B.E., B.Sc., Mr. A. J. Sims, O.B.E., R.C.N.C., and Mr. H. E. Steel, C.B.E.; and, as Associate Members of Council, of Mr. Alexander Belch, C.B.E., Captain J. P. Thomson, O.B.E., and Mr. W. C. S. Wigley, M.A.

Presentation of Awards

The awards announced in the Council's Report were then presented by the President. They were as follows: the William Froude Gold Medal to Professor Sir Thomas H. Havelock, M.A., D.Sc., F.R.S.; Institution Premiums to Dr. W. Muckle, M.Sc., Ph.D., for his paper on "The Influence of Proportions on the Behaviour of Partial Superstructures constructed of Aluminium Alloy," and to Professor G. Aertssen for his paper on "Sea Trials on a 9,500 tons Deadweight Motor Cargo Liner"; the Samuel Baxter Prize (of £60) to Mr. W. J. Holt, R.C.N.C., for his paper on "Recent Developments in Naval Life-Saving Equipment"; and the Watts Prize (£50) to Mr. J. E. Church for his paper on "Crew Accommodation for an Improved Type of Dry Cargo Vessel."

President's Address

The President then delivered his address. He began by commenting on the previous Autumn Meeting, which had been held in Yugoslavia. This unusual occasion, he felt, had surely contributed something towards the friendship of the two countries. He next referred to the subject of nuclear energy, which had been mentioned in the Annual Report, by observing that the Institution of Naval Architects was well represented on the panel set up by the Institution of Marine Engineers in conjunction with other appropriate bodies to study the matter. He understood that the Admiralty believed it to be only a question of time before nuclear energy was the main source of power, not only for warships, but also for merchant vessels. How long that time might be, he did not know, but he would be very interested to hear if any shipowners had yet placed orders for vessels with such engines.

CONSERVING MEN AND MATERIALS

During the year, generally speaking, while it had been comparatively easy for the shipowner to place an order, it had been extraordinarily difficult to get the results. He did not wish to labour that point. Everyone knew what a shortage there was of skilled shipyard labour and of design and drawing staffs and that

many people besides shipbuilders wanted steel plates. It was also common knowledge that a large number of people wanted ships, and it was not surprising that order books should be full and that the cost of ships should show no immediate sign of a substantial drop. At the same time, he thought this a satisfactory position from a number of points of view, because there was at least no visible over-production of ships in the world. It probably did not matter very much if everybody else's costs were as high; but it was a little disturbing to hear from time to time the suggestion that there were countries, other than our own, capable of producing quite good ships at prices and in times which the shipowner—who, after all, had to compete in the international market—would be tempted to accept. He did not know whether as an Institution they could do anything about it, or if it was in fact their business to do so. They were largely an international body, and their purpose was to see that the design of ships was improved, rather than to tell various people, and those who worked for them, how to carry out their designs.

It had been said that, in times like the present, it was more important than ever that designs should be good; and it was more than ever a factor of a good design that it should be economical, both in the use of materials and in cost of running the ship. That he believed to be just as true for Her Majesty's ships as for those concerned with commerce.

Lord Runciman was interested to see that the Admiralty were continuing their researches into new materials. The use of plastics was being ever more seriously considered, and more particularly the use of plastics for boats. He hoped that, if and when the development of such practices gave rise to ships' lifeboats constructed in plastics, it would not be found, as in the past, that the conservatism of the Ministry of Transport was greater than its desire to see the application of modern developments.

BARNACLE DETERRENTS

Not unconnected with the use of new materials was that other problem to which enough attention could never be devoted, namely, the general simplification of upkeep and maintenance. He had said before in plaintive tones to the Institution that he could not understand why nobody had invented something which would be extremely distasteful to barnacles; it was still necessary to put ships into large holes, very expensively dug out, in order to apply to their bottoms substances which did not stay there long enough. There remained much room for research on the protection of the underwater parts of ships, as much from organic creatures as from ordinary corrosion. The progress of anodic protection was of course well known, but alone was not enough. He gathered that particularly in Her Majesty's ships, various developments were under consideration and much work was being done, the results of which no doubt Their Lordships would, in the course of time, make generally available if they thought the information worth communicating.

Returning to the question of maintenance and upkeep, he considered it almost certain that, throughout the world at large, the labour of human hands would be in fairly short supply for some time to come. That being so, it was not only commercial common sense, but a major public duty, to ensure that as far as possible human labour was not wasted in doing things which could be done in other ways. The question of the maintenance of ships would, he believed, become increasingly important with the passing of time.

Shipbuilding and ship design had a fairly long history behind them, and would without doubt have a fairly long history ahead. The design of ships was a slow and laborious process. No ship ever had been or ever would be perfect. It was chiefly a matter, he thought—and perhaps the public were rather apt to overlook this—of being quite sure of the job a particular ship was required to do, and of making sure that the best ship was built for the job.

MASS-PRODUCED SHIPS REJECTED

One of the facile assumptions of non-technical people was that a ship was like a motor car, that it could be produced in series and that one would work as well as the one before. In time of war that was the only way to survive; but those who had experience of trying to run ships under conditions of not very brisk international trade in times of peace knew perfectly well that the only way of fulfilling at a reasonable cost the requirements of the world for sea carriage was to be quite sure that, in any particular trade, ships most suited to that trade were used. No one should be disturbed by people who said "Why can't you run your ships like motor cars?." Probably shipbuilding members would reply, "If that is what you want us to do, we can and will do it." He was quite sure, however, that Their Lordships of the Admiralty would feel, as he did, that if shipbuilders once did that, shipowners would begin ordering ships in some other country where such practices were not employed.

It was in that long process of evolving particular designs for particular purposes that the Institution would continue, as in the past, to play a valuable part and, although 1955 had contributed nothing spectacular, it had at least been a further and useful step in the right direction.

To be continued

CONFERENCES AND LECTURE COURSES

Arrangements to hold conferences and courses of lectures on a wide range of subjects have been made during the past few weeks. Among them may be mentioned the following:

Human Factors in Road Transport

Symposium, from April 16 to 19, organised by the Ergonomics Research Society at the University of Bristol. Accommodation provided at Manor Hall, York-place, Bristol 8. There will be papers on glare, flashing indicators, driver behaviour, physiological aspects, and transport by muscle power, and, probably, visits to the works of the Bristol Aeroplane Company, Limited, and the Bristol Tramways and Carriage Company, Limited. Apply to Mr. H. Murrell, 22 Berkeley-square, Bristol 8.

Instrumentation in Factories

Conference, from April 19 to 22, organised by the Association of British Chemical Manufacturers, at the Hotel Majestic, Harrogate. Intended for senior executives, will not be highly technical, and will be accompanied by a display of modern measurement and control apparatus. Apply to the Association: 86 Strand, London, W.C.2.

Electrical Equipment of Aircraft

Conference, from May 2 to 4, organised by the Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2, to be held in the Institution building. Some 20 papers, dealing with the special design problems of electrical systems in aircraft, will be presented. Open to non-members on payment of £1 as registration fee.

Electricity in the Tropics

Study Conference, on May 28 and 29, on problems raised by electrification in tropical countries, to be held in Paris. Organised by the Union Internationale des Producteurs et Distributeurs d'Energie Electrique (U.N.I.P.E.D.E.), the conference will deal with plant operation, distribution systems and transmission lines. Apply to the secretary's office at Electricité de France, 77 Avenue Raymond Poincaré, Paris, preferably through Mr. V. A. H. Clements, Central Electricity Authority, Bankside House, Sumner-street, London, S.E.1.

Welding Problems

Sixth summer school, from June 18 to 23, organised by the British Welding Research Association, at Ashorne Hill, near Leamington Spa, Warwickshire. Intended chiefly for research staffs, managers and engineers concerned in arranging welding processes and in selecting materials for welding. Apply to the Association's offices: 29 Park-crescent, London, W.1.

Managers in Industry

Fourth course, from June 25 to July 21, organised by the University of Cambridge at Madingley Hall, for managers with industrial experience who are under 40 years of age. Topics for discussion will include human problems in industry, Britain's international position, and the changing structure of the national economy in relation to management. Apply to Mr. G. F. Hickson, Stuart House, Cambridge.

Automatic Controls

Full-time courses, from July 23 to August 3 and from September 3 to 14, respectively, arranged by the Department of Electrical Engineering of Loughborough College of Technology, at the College, Loughborough. These courses will be of an introductory nature, non-mathematical in character and will deal with the fundamental techniques normally in use. Lectures will be followed by works visits. Apply to the head of the Department, as above.

Damascus Fair

To be held at Damascus from September 1 to 30. There will be a United Kingdom pavilion for British goods, organised by the Federation of British Industries. Apply to British Overseas Fairs Limited, 21 Tothill-street, London, S.W.1.

Applied Mechanics Problems

The ninth international congress to be sponsored by the International Union of Mechanics will take place at the Université Libre, Brussels, from September 5 to 13. Subjects to be dealt with will include aerodynamics, fluid dynamics, and the mechanics of solids (rigid dynamics, vibrations, elasticity and plasticity). There will be lectures of general interest, in addition. Apply to the general secretariat, Université Libre de Bruxelles, 50 Avenue F.-D. Roosevelt, Brussels.

Ferrites

Convention, on October 25 and following days, organised by the Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2, to be held at the Institution building. This group of chemical compounds, which possesses properties different from metals on the one hand and dust cores on the other, is widely used in place of conventional soft magnetic-core materials and permanent magnetic materials in radio, television and communications equipment. More recently, ferrites with almost rectangular hysteresis loops have been discovered and these are being applied as storage elements in electronic computers. Further particulars regarding this convention will be made available by the Institution later.

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ELECTRICITY SUPPLY

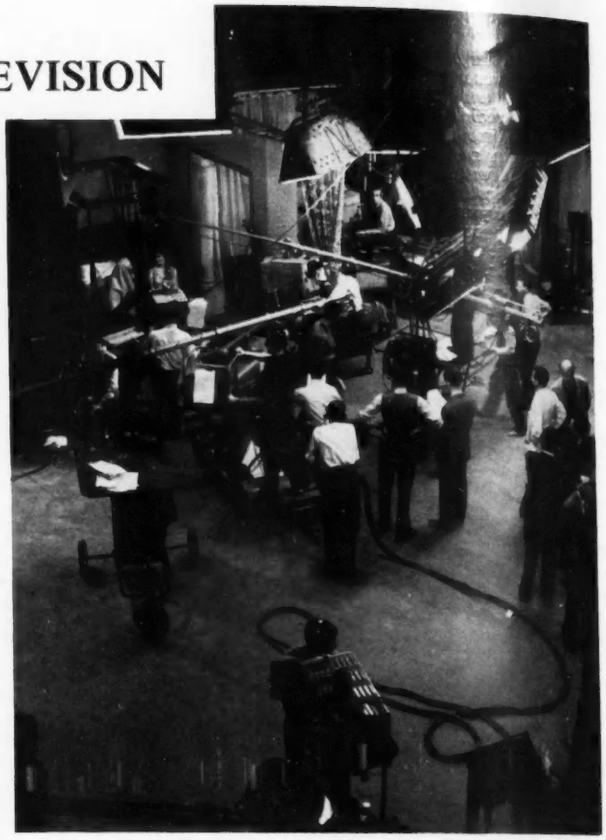
Large Increase in Domestic Consumption

During February, 7,436 million kWh were sold by the Central Electricity Authority to the English and Welsh Area Boards. This was an increase of no less than 21·2 per cent. over the output for February, 1955, although when corrected for weather conditions and working days the figure is reduced to 8·2 per cent.

The amount of electricity sent out by the Area Boards during the same month was also 7,436 million kWh, of which 166 million kWh were supplied direct by the Central Authority. The increases in the amounts sent out, compared with the corresponding figures in February, 1955, were 16·2 per cent. in the "mainly industrial" and 29 per cent. in the "mainly non-industrial" areas.

Book Reviews

THE ENGINEERING OF TELEVISION



Color Television Engineering. By JOHN W. WENTWORTH. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (8 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (60*s.*)

Now that television is really getting into its stride in many countries in the world it is not surprising that a number of authoritative technical books on the subject are appearing. In view of the stabilisation of systems which has taken place during the past few years it is likely that the contents of these books will not become out of date as rapidly as has been the case in the past.

Mr. Wentworth's book is of great interest. It conveys the impression that it has been written by an author who is a good and experienced lecturer. Indeed, it is based on notes used by him for lectures in after-hours courses for the staff of the Radio Corporation of America at Camden, New Jersey. The book is divided into an introduction and four parts. Part I covers the basic principles of colour, colour perception and colour measurement, Part II the principles of colour reproduction, Part III the principles of colour television transmitter systems, and Part IV deals with apparatus and circuits for colour television.

The fact that not until the last part is reached does any sign of an electrical circuit appear shows that the book gives an extremely thorough grounding in the principles of colour. This is the very subject which is liable to be least understood by the true television engineer, due of course to the fact that it is quite outside his experience in black-and-white television. Moreover, in dealing with the subject the author is very readable. Starting from the simplest concepts of light he takes the reader easily through the physical followed by the physiological aspects of colour, the measurement and specification of colour and the application of colorimetry to television. The book contains the best build-up to the C.I.E. chromaticity diagram that the reviewer has met.

Anyone who has worked on colour television realises that a fair knowledge of colour photography processes is indispensable, and it is pleasing to find Chapter V devoted to this subject. The author next considers transfer characteristics in colour reproducing systems and goes on to discuss colour television as an information transfer problem. The preceding matter occupies 200 pages and after this grounding we begin to turn towards actual colour television in the chapter entitled " Multiplexing techniques for compatible colour television systems," which is amplified in the following chapter entitled " Time-multiplexing or sequential colour television systems." Now follows Part IV, the contents of which are more conventional and deal with the physical apparatus used in colour television transmitters and receivers. The book concludes with a section on colour television test equipment and various appendices.

It is not a book for the engineer who wishes to study the electronics of colour television, but information of this kind is available elsewhere. The outstanding value of the book is its clear presentation of fundamental colour theory and the marriage of this theory with that of television engineering.

Fundamentals of Television Engineering. By GLENN M. GLASFORD. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (9·50 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (71*s.* 6*d.*)

This is a weighty book from an author who has been responsible for much electronic and television research at the radiation laboratory of the Massachusetts Institute of Technology and the Allen B. Dumont Laboratories. It is definitely a teaching book and the material is designed to fit both graduate and undergraduate courses of study in America. It has been used for this purpose at Syracuse University.

The book covers the whole field of television engineering, starting with the elements of a television system and proceeding through the basic theory, fundamentals of scanning, image tubes and output circuits, visual display tubes, video amplifiers, wide-band radio-frequency amplifiers, transmission systems, signal circuit problems and techniques, scanning and synchronisation, and concluding with substantial chapters on the television camera and its associated equipment, practical transmitters and aerials and television receivers.

It is noteworthy that colour television is not any longer regarded as a somewhat immature addition to black-and-white television but is considered alongside the earlier science throughout the book. Thus, in Chapter 2, where the author discusses the nature of the signal to be transmitted over television, he follows his analyses of black-and-white sensations with a similar colour analysis, though it is rather brief.

Chapter 7 is noteworthy: in the previous chapter the author has discussed video amplifiers, using mostly steady-state analysis principles, but he is not satisfied to leave the matter there and covers the ground again from the transient angle in Chapter 7. This is particularly useful in view of the marked preference of many engineers for either one or the other method of approach. Another somewhat unusual chapter of particular value is the ninth, " The transmitter-receiver relationship." Here we get a full account of vestigial sideband transmission, which is too frequently thought of from the transmitter angle alone.

The heading of Chapter 10, " Signal circuit problems and techniques," is perhaps a trifle misleading and would be better entitled " Miscellaneous circuit techniques." Here are collected accounts of a number of specialised television circuits, but we also get line theory both for video and radio frequencies and even wave guides—a unique assembly of subjects which, however, go together quite well. There follow 95 pages devoted to scanning and synchronising, after which we come to practical apparatus, which includes an excellent section on transmitting and receiving aerials.

The book is mathematical to a moderate standard, that is to say the great bulk of the mathematics consist of the ordinary algebraic processes, but there is one stage where the author requires the use of transformation calculus. It is noteworthy for the number, clarity and excellence of the diagrams, an aspect of technical literature which must often arouse some criticism. It may be recommended as an excellent general text-book on black-and-white and colour television, but clearly the author expects the reader to look elsewhere for anything but the briefest mention of colour theory. In this sense his book is complementary to that by Mr. Wentworth.

Color Television Fundamentals. By MILTON S. KIVER. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (4.50 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (32*s.* 6*d.*)

Mr. Kiver's intention is to enable a television engineer experienced in the science of black-and-white television to prepare himself to enter the newly opening field of colour television. His book is designed for junior technical colleges and technical institutes and for home study.

It is evident, however, that the type of engineer the author has in mind is the servicing engineer rather than the overall system engineer, to whom the two previous books have been addressed. Thus, while approximately 10 per cent. of the previous two books is devoted to receiver design, no less than 85 per cent. of the present book is about this subject, and the author devotes no more than the first 40 pages, or 15 per cent. of the book, to colour fundamentals and the N.T.S.C. system. It is therefore a specialised book on colour television receivers, and it is entirely non-mathematical. As has been stated, the first two chapters briefly refresh our minds on the N.T.S.C. system and the third chapter goes on to the three-gun colour receiver in block form, to be followed immediately by two chapters about circuits and a third having the somewhat ambiguous heading of " Narrow band colour receivers." This nomenclature, however, merely signifies the very usual type of colour receiver which on American standards has a luminance bandwidth of just over 3 Mc/s and a chrominance bandwidth of 1·5 Mc/s. It is not without interest to see these bandwidths openly described as " narrow " by an American author. There is then a useful chapter on display tubes of various sorts, followed by one on deflection and convergence circuits.

The true purpose of the book becomes fully revealed in the next two chapters, entitled respectively "Typical colour television receivers: analysis and alignment" and "Colour television servicing." The book is not notable for its erudition but it is a practical, down-to-earth work for the young television engineer of moderate attainments who is doing the very necessary job of keeping in order the growing number of colour television receivers in the United States. It is too early for such a book to appear in Britain and of course when colour television is launched here there may have been considerable developments which would limit a part, but by no means all, of the usefulness of the book.

REGULAR INSPECTION OF PLANT SMOOTHS OIL REFINERY OPERATION

The Petroleum Refinery Engineer's Handbook. By J. F. STRACHAN. *E. and F. N. Spon, Limited, 22 Henrietta-street, London, W.C.2.* (50*s.*)

Probably no other industry in this country has made such rapid progress since the war as the oil industry. The key to its success has been an insistence on the use of up-to-date plant and processes, and the most careful attention to economical operation. In a continuous process such as oil refining equipment must give the maximum of service once installed; it must be "let down" for maintenance and repairs only when absolutely necessary, and then for as short a time as possible. The raw material is subjected to considerable pressure or temperature; thus regular and rigid inspection of equipment is a standard feature of the operating programme. As works of reference on inspection in oil refineries are relatively few, this new book is of special interest.

It is written by Mr. J. F. Strachan, formerly chief plant inspector to the British Petroleum Company, Limited, and is a second edition of his *Practical Inspection of Oil Refining Equipment*, which was published privately in 1947. The earlier book was received with such enthusiasm, not only in Mr. Strachan's company, but throughout the oil industry, that he was encouraged to produce the new and revised edition for general publication. In *The Petroleum Refinery Engineer's Handbook*, he describes briefly the latest processes employed in refining practice, the use of new methods to combat corrosion, and, in detail, the techniques of inspection as they apply to refining plant. It may be significant that the title of the new book omits the word "inspection"; certainly the range of interest of the book is such that it will be invaluable to any engineer concerned with the operation or maintenance of refinery equipment, irrespective of whether he is responsible for inspection.

Broadly speaking, the book falls into three parts, the first describing the organisation, personnel and methods of a typical inspection department, the second outlining inspection procedures, and the third dealing with one of the most intractable of the oil industry's problems—corrosion. In reading through the pages one comes to realise Mr. Strachan's profound belief in the value of inspection. He regards it as one of the most important aspects of running a refinery. His remarks on the qualities required in a good plant inspector illustrate his attitude to this work. "The exacting nature of plant inspection work," he says, "calls for men of integrity and firmness of character, as well as of high technical ability." The pages in which he gives a detailed description of the many tests and pieces of equipment which are the stock-in-trade of the job are some of the best in the book. They portray in simple language and with the aid of concise diagrams just how the oil refinery plant inspector should go about his task, what tools he should employ, and how he should record his findings so that maximum use may be made of them.

In the second chapter Mr. Strachan gives an analysis of the main sections of a refinery's operations; (1) cracking and reforming, (2) distillation, (3) special products, (4) refining, (5) construction, and (6) safety valves, this being the order of importance as far as inspection is concerned. Under each heading he defines the main duties and problems of the plant inspector, and gives many useful tips culled from his own considerable experience.

A close watch for the onset of corrosion in pipes and vessels is one of the chief preoccupations of the oil refinery inspector, and time and time again the author returns to the subject. In fact, he devotes a 24-page chapter to a consideration of corrosion and its effects, apart from many references to them in other parts of the volume. The problem is particularly acute in cracking and pressure distillation equipment, and Mr. Strachan says that in this plant "practically all forms of wastage occur." From a 16-page photographic supplement, showing the types of corrosion found in an oil refinery, one can see the truth of his statement, and can appreciate the immense importance of adequate and regular inspection of such plant. The author shows how modern techniques of inspection involving electrical and electronic methods and the principles of gamma and X-ray penetration, together with the use of new materials, are helping to solve the problem.

Although devoted to a specialised branch of engineering, *The Petroleum Refinery Engineer's Handbook* will make interesting reading to any fuel technologist who takes a broad view of his work. For the oil industry, and for plant manufacturers, there can be little doubt that it will become a standard text-book.

STEELWORK ON THE DRAWING BOARD

Steel Designers' Manual. Prepared for the British Steel Producers' Conference in conjunction with the British Iron and Steel Federation by CHARLES S. GRAY, LEWIS E. KENT, W. A. MITCHELL and G. BERNARD GODFREY. Second impression. *Crosby Lockwood and Son, Limited, 26 Old Brompton-road, London, S.W.7.* (50*s.*)

This book satisfies a long felt want in the technical literature of this country; indeed, it might be called the counterpart of "Ketchum" in the United States. The fact that a second impression has been found necessary within a year of the first publication speaks for the popularity of the book. The sponsors are to be congratulated on initiating such a publication, not only for so doing but also for the manner in which they have dealt with the problem. No doubt they realised that the preparation of such a volume was too herculean a task for any one man, however able, and wisely decided to entrust the work to a team of authors.

In the foreword it is stated that the *Manual* is intended to bridge the gap between the normal textbook on the theory of design and its practical application to constructional engineering. Within these limits the authors have succeeded admirably in their task. Throughout the book, the accent is on buildings both of the office block and of the industrial type and in that respect the title of the *Manual* is somewhat misleading. While it is a truism that in writing any textbook the author is faced with the difficulty of compressing his text into a given space and hence with the question of what can (or must) be omitted, it is a matter of regret that no attempt has been made to deal with bridge design. Although this can be excused for the reasons already mentioned, it is worth noting that no textbook on the design of steel bridges has been published in this country since before the war. It is, therefore, to be hoped that the authorities who sponsored the present volume will turn their attention to this matter with the same happy result.

As has already been pointed out elsewhere, the keyword is information rather than derivation, and while there is always a certain degree of risk in presenting information in tabloid form to the uninitiated, the *Manual* is a *sine qua non* for the modern design office and a mine of information to practising engineers of all ages. The outstanding feature is the amount of up-to-date and in some cases hitherto unpublished information which it contains. If any one portion can be singled out for special mention, it might well be said that the most valuable sections are those dealing with modern methods of construction such as portals and stressed-skin construction. The extracts from Kleinlogel's classic work are specially valuable for reference and for design. The sections dealing with methods of analysis which have proved so useful in modern practice, such as moment distribution, column analogy, and so on, are admirable and it is good to find that other less known but perhaps equally useful methods of analysis have not been omitted. On the subject of analysis it may be noted that, in the section dealing with plane frames, no mention is made of the method of tension coefficients nor the methods for solving redundant frames. It would, perhaps, have been more logical to have placed the matter dealt with in sections 16 and 17 —"Geometrical Properties of Sections" and "Bending and Axial Stresses"—in an earlier part of the book. The sections dealing with connections are excellent, but the method of dealing with bracket loads on page 666 is open to criticism.

The latter part is devoted to practical details such as cladding, floors and walls (a welcome innovation in British text-books). Throughout the *Manual* a considerable amount of space is devoted to tables and graphs which should save time in the design office when used intelligently.

The presentation of the text and illustrations leaves nothing to be desired, and the work of the publishers and printer sets a standard of production which it would be difficult to excel. Although the price is rather higher than that of the general run of text-books, this must be considered in the light of the amount of information which has been successfully compressed into a single volume thereby making it a valuable addition to the library of the engineer who wishes to keep abreast of modern practice.

★ ★ ★

The facilities now available for combining recreation and study on holiday are listed in a new edition of *Vacations Abroad*, published for UNESCO by H.M. Stationery Office, price 5*s.* Specific reference is made to visits to industrial plants, etc., and appendices give the names of international organisations sponsoring vocational activities, other sources of information, as well as lists of hostels and other suitable accommodation for students.

The wide selection of educational and other activities are grouped under Vacation Courses, Study Tours and Work Camps. The section on hostels, holiday camps and similar centres is included for the first time. Beside the purely educational aspect, the guide offers a choice from some of the best possible ways of enjoying a well-planned holiday, gaining at the same time an insight into the ways of other countries and benefiting from an exchange of ideas with people of other nationalities. So far as possible, exact information is given on dates of courses, places, subjects and costs. A special section on vacational scholarships lists some of the sources of financial aid available to those wishing to participate in summer schools. The individual entries include information on reduced fares and similar facilities where available. Some vacation courses provide opportunities for serious study of the language and culture of the country in which they are held; others form international discussion groups, usually on current social or economic themes.

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

X-Ray Protection. National Bureau of Standards Handbook 60. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (20 cents.)

This booklet contains the recommendations of the National Committee on Radiation Protection of the United States of America. It supersedes an earlier handbook " Medical X-Ray Protection up to Two Million Volts," which was published in 1949. It covers such matters as planning and inspection, working conditions, structural details of protective barriers, medical and dental installations and fluorographic equipment.

Winding Engine Calculations for the Mining Engineer. By A. B. PRICE. Second edition. *The General Electric Company, Limited, Fraser and Chalmers Engineering Works, Erith, Kent.* (30*s*.)

This book contains examples of the most modern winding practice, although a chapter on steam winders has also been included. The present edition has been revised to include more details of friction machines, both of the Koepe and multi-rope types. The complexities of design, both as regards United Kingdom and overseas practice are described at length. A chapter is included on inclined shafts in which the mechanics of this method are considered.

Proceedings of the Conference on Building Research, Ottawa, October 21 to 23, 1953. *National Research Council, Division of Building Research, Ottawa, Canada.* (3.50 dols.)

The opening of the laboratory of the Canadian Building Research Division in 1953 was celebrated by a conference on building research, and the present volume is a report of that conference. It includes three reviews of contemporary work in Great Britain, the United States and Scandinavia, by the directors of research in those countries. Nineteen papers were also delivered under three main headings: housing research, where problems of organisation, construction and new materials were discussed; secondly, a group of six papers discussing moisture in solid materials and the effect of water on the properties of certain building materials; and thirdly a group of papers concerned with specific building problems in Canada, in particular those due to cold weather. Among the other problems referred to in the third group are those of organising library services, research work done for the Toronto subway and fire research in Canada.

Arithmetic for Engineers. By CHARLES B. CLAPHAM. Fifth edition. *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (21*s*.)

This is one of the " Directly Useful " technical series and was first published in 1916. The fifth edition has been corrected and brought up to date by a large addendum. It begins with the fundamentals of mathematics and includes chapters on logarithms, graphs and trigonometry. There are exercises attached to each chapter.

Modern Brickmaking. By ALFRED B. SEARLE. Fourth edition. *Ernest Benn, Limited, Bouverie House, Fleet-street, London, E.C.4.* (90*s*.)

This book was first published in 1911 and later revised and enlarged in 1920 and 1931. A fourth edition with yet further material has now been published, so bringing the book up to date to include details of the many scientific discoveries and advantages in technical processes that have been made in the industry in the last 20 years. In particular, this includes applications of X-ray techniques, studies of base exchange, increases in the knowledge of plasticity and the process of drying, together with references to important changes in the design of the machines used.

Electronic and Radio Engineering. By PROFESSOR FREDERICK EMMONS TERMAN. Fourth edition. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (9.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (71*s*. 6*d*.)

Intended as a text and reference book, this 1,000-page volume covers the whole field of electronics. It begins with the elements of a radio communication system and continues with circuit theory and electronic engineering fundamentals; radio engineering and radio systems form the last section of the book and each of the 26 chapters ends with a series of problems and exercises.

A.C. Generators and Motors. By PHILIP KEMP and W. H. DATE. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2.* (6*s*. 6*d*.)

This small text-book is designed for students working for the City and Guilds or National Certificates, and gives the basic particulars of alternating current generators and motors. It is reprinted from " Electrical Wiring and Contracting " as a single volume for the convenience of students.

Electrical Interference. By A. P. HALE. *Heywood and Company, Limited, Drury House, Russell-street, London, W.C.2.* (15*s*.)

This book deals with interference with radio and television reception, 140,000 complaints about which were made to the General Post Office in 1954. It is written from the practical point of view and covers both causes and effects. Among the related subjects dealt with are receiver aerial systems, measurement of interference levels, location of sources of interference, avoidance of interference, basic filters and safety. A series of photographs of a television screen show the effects of the different types of interference on the picture. There is a good bibliography.

The following reports may be obtained from the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey:

The Effect of Enclosure on the Temperature Rise of Fuses. By H. W. BAXTER. No. G/T297. (10*s*. 6*d*.) The object of this investigation was to devise a simple method of estimating the temperature-rise of fuses when mounted in enclosures. It is a simple matter to measure the temperature-rise of a fuse, but there are so many ways of mounting fuses that it would be very tedious, even impracticable, to measure the rise under all possible conditions of service. Because of this, it was thought that the best method of attacking the problem was to ascertain how heat is dissipated from a fuse, since it might then be possible to evolve an empirical method of estimating the rise under a wide range of conditions.

On the Thermal Excitation of Trapped Electrons in Ionic Solids. By J. H. SIMPSON. No. L/T317. (12*s*. 6*d*.) Measurement of the ground state energy of an electron trapped at a defect of the interstitial or substitutional type in an ionic crystal is compared with static calculations using a self-consistent method.

Gas Temperature in Argon Spark Channels. By R. D. CRAIG. No. L/T318. (6*s*.) The programme of research work on spark channels and arc discharges in the Department of Electrical Engineering at Liverpool University involves measurements of discharge temperatures (including electron and gas temperatures), and this report gives preliminary data obtained in trial experiments.

Stray Losses in Transformer Cores. Critical Résumé. No. Q/T124. (12*s*.) This report briefly reviews the calculation of iron losses in transformer cores. Digests are given of articles about losses in joints, corners, interlamination insulation and subsidiary parts such as core bolts and clamps, as well as losses due to strains in the iron. The calculation of apparent loss in a given shape of core is considered and a bibliography is appended.

Stresses in High-Voltage Condenser-Bushings. By S. SILBERMANN. No. Q/T125. (12*s*.) This report deals with the problem of stresses in high-voltage condenser-bushings from a practical point of view and gives actual figures for the stresses involved and shows how excessive stresses can be reduced.

The Applications of Electricity to Crop Drying on Farms: A Critical Review. By P. FINN-KELCEY. No. W/T25. (24*s*.) A comprehensive review covers the drying of herbage crops as well as grain and seeds. Methods of drying grass with and without heat are discussed, and the different types of apparatus described. Barn hay drying and drying methods for grain, seed and hops are also dealt with. A bibliography of 41 references is appended.

Color Television Standards. Selected Papers and Records of the National Television System Committee. Edited by DONALD G. FINK. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (8.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (64*s*.)

This book has been compiled from the proceedings of the Second National Television System Committee of the United States on whose recommendations the colour television standards adopted by the Federal Communications Commission were based in 1953. It is prefaced by an historical summary of the development of colour television between 1940 and 1953, and includes a general description of the Committee's proposals as well as the technical methods needed for the development of a nation-wide service. Colour video and synchronisation signals, field tests of compatibility, colour performance, networks, transmitters and colour films are also dealt with.

Color Television Engineering. By JOHN W. WENTWORTH. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (8 dols.) ; and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (60*s*.) (Reviewed on page 208.)

Fundamentals of Television Engineering. By GLENN M. GLASFORD. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (9.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (71*s*. 6*d*.) (Reviewed on page 208.)

Color Television Fundamentals. By MILTON S. KIVER. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (4.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (32*s*. 6*d*.) (Reviewed on page 208.)

The Petroleum Refinery Engineer's Handbook. By J. F. STRACHAN. *E. and F. N. Spon, Limited, 22 Henrietta-street, London, W.C.2.* (50*s*.) (Reviewed on page 209.)

Steel Designers' Manual. Prepared for the British Steel Producers' Conference in conjunction with the British Iron and Steel Federation by CHARLES S. GRAY, LEWIS E. KENT, W. A. MITCHELL and G. BERNARD GODFREY. Second impression. *Crosby Lockwood and Son, Limited, 26 Old Brompton-road, London, S.W.7.* (50*s*.) (Reviewed on page 209.)

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Design of Large Turbo-Alternators. GENERAL ELECTRIC CO. LTD., Witton, Birmingham, 6. Descriptions of the steps that have been taken to increase the maximum output obtainable from a given frame size of large turbo-alternator and of the system of direct cooling using rectangular copper tubes that has been developed by the company. In this system hydrogen is drawn from one end of the rotor to the other and the advantages of this arrangement from the constructional and operational points of view are discussed. Illustrated pamphlet P3192.

Electricity Supply in Great Britain—Seven Year Record, 1948-1955. CENTRAL ELECTRICITY AUTHORITY, Trafalgar Buildings, London, S.W.1. A brief review of the outstanding developments in electricity supply in Great Britain during the first seven years of national ownership and operation. Historical details—including the difficulties due to shortage of plant—encountered by the Authority in the early years. Economics acruing from large-scale operation. A glimpse into the future with special reference to plant construction and nuclear reactor power stations. Booklet, fully illustrated with photographs and diagrams.

Braille AvoMeter. AUTOMATIC COIL WINDER AND ELECTRICAL EQUIPMENT CO., LTD., 92 Vauxhall Bridge-road, London, S.W.1. Details of the standard Model 7 AvoMeter, which has been adapted for use by the blind. A mechanical pointer carries an internal feeler, which follows up the electrical pointer until it comes into contact with the latter when it encounters resistance to further movement. The top of the mechanical pointer protrudes between two sections of a Braille scale and its position in relation to a set of markings can be read. Illustrated leaflet.

Thermal Insulation for Buildings. THERMALITE LTD., Shepherds House-lane, Reading, Berkshire " Thermalite "—a lightweight structural building material, combining the functions of load-bearing and thermal insulation. Developed in the laboratories of John Laing & Son, Ltd., Boreham Wood, Herts. Details and properties, and notes on use of Thermalite. Illustrated booklet.

Wirewa Metal Ducting. NATIONAL PRODUCTS CORPORATION, Pittsburgh 22, Pennsylvania, U.S.A. Details of 4 in. by 4 in. and 6 in. by 6 in. metal ducting for housing electric wires and cables. Access through a hinged lid, enabling repairs or extensions to be carried out without disturbing existing work. Illustrated pamphlet.

Radio Accessories. DERF RADIO CO., 17 Hudson-street, New York 13. Price list of potentiometers, capacitors, reactors, rheostats and other radio accessories. Illustrated leaflet.

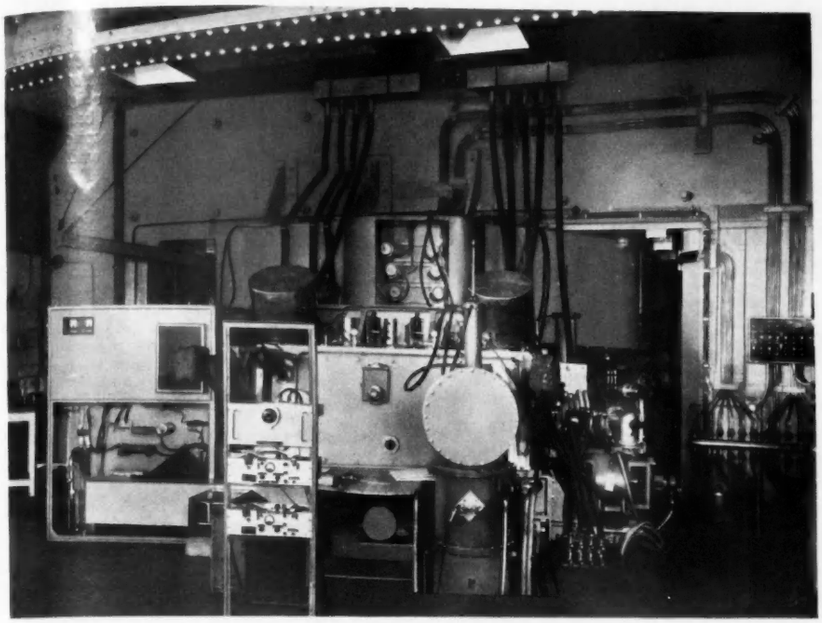

Fig. 1 The 156 in. synchrocyclotron in the Nuclear Physics Laboratory at Liverpool University.

156 IN. SYNCHROCYCLOTRON AT LIVERPOOL

A RECENT AID TO NUCLEAR RESEARCH

A synchrocyclotron, which is said to be the largest of its type in Western Europe, is now in operation in the Nuclear Physics Laboratory at Liverpool University. It is designed to accelerate heavy particles of matter—initially protons and later deuterons—to energy levels high enough to disrupt atomic nuclei. These nuclei release unstable particles, the properties of which can then be studied under controlled conditions. For instance, many of the particles recently discovered in cosmic radiation can be artificially produced and their properties observed. The equipment, of which an illustration is given in Fig. 1, is capable of generating a beam of protons at an energy of 410 million electron volts with a beam intensity of about one microampere. An extracted beam of 383 million electron volt protons with an intensity of about one-thirtieth of a microampere is available in the experimental room.

The provision of this synchrocyclotron was initiated by Sir James Chadwick, then professor of physics at Liverpool, and was carried on by his successor, Professor H. W. B. Skinner. It was designed by Metropolitan-Vickers Electrical Company, Limited, in co-operation with Liverpool University and was constructed at Trafford Park.

OPERATING PRINCIPLES

The synchrocyclotron is operated by ionising hydrogen gas and introducing the protons thus generated into the centre of a flat vacuum chamber, which is situated between the poles of a magnet. This chamber contains two electrodes which are excited at radio frequency and produce a high-intensity electric field. The ions are thus accelerated; and under the influence of the magnetic field move in a series of semi-circular paths, the radii of which gradually increase. Thus, the orbits they describe are spiral and their energy rises as they approach the outer diameter of the magnetic poles. At Liverpool they are then extracted by a number of magnetic deflectors, in which a "peeler" and a regenerator are employed.

LAYOUT OF EQUIPMENT

The synchrocyclotron is installed in a room one side of which and the basement below it are bounded by solid sandstone rock. The remaining sides consist of concrete walls 6 ft. thick with additional packed sandstone and brick walls to a thickness of several feet. The ceiling is of 5 ft. 6 in. thick concrete. A plan of the layout is given in Fig. 2.

The foundations of the main magnet are at basement floor level and the magnet itself rises some 22 ft. to within 2 ft. of the ceiling. The vacuum pumping equipment and other auxiliaries are also installed in the basement and above them is an open-mesh removable ceiling, which forms the operating floor and from which access is obtainable to the vacuum chamber, magnet pole gap and other parts of the installation.

The room is entered through a "door" consisting of two concentric steel cylinders, which are erected vertically inside a 13 ft. mass concrete wall. The outer cylinder is about 7 ft. in diameter and 14 ft. long and an aperture 4 ft. wide by 6 ft. high is cut through both its sides and the wall. The inner cylinder, which is about the same length, is free to move vertically within the outer cylinder. It is filled with sand and can be raised or lowered by a motor-driven hoist. It normally rests on spring-loaded buffers, the aperture in the outer cylinder being then uncovered and the top cover of the inner cylinder forming a walk-way, level with the floor of the cyclotron room. When the inner cylinder is raised the aperture is sealed off by the sand, thus forming a barrier to high intensity radiations. The cylinder is maintained in the raised position by solenoid-operated brakes, so that in the event of a power failure it falls at a controlled speed until it comes to rest on the buffers.

Experimental equipment, including beam-bending arrangements and cloud chambers, are installed in an ante-room, which is divided from the cyclotron room by removable blocks of steel-filled concrete. An auxiliary equipment room houses a motor-generator set for magnet excitation with its control equipment, a high-voltage rectifier, switchgear and control panels and water cooling and purification plant. The equipment is operated from a control room situated about 50 yards from the cyclotron room. Much of it can also be controlled locally, although to avoid risk to the operator an ion beam cannot be produced in this way.

THE ION SOURCE

The hydrogen or deuterium gas required for ionisation is drawn from a cylinder through a regulating valve to a supply unit, which contains a variable leak, a Pirani gauge and a magnetic valve. The leak consists of a length of flattened tube in the form of a long U, that is wound round a shaft to which the bottom of the U is brazed. The ends of the U are restrained, so that a variable rate of leakage can be obtained by tightening or slackening the flattened tube round the shaft, which is driven through gearing by a split-field motor.

The gas is supplied to the main vacuum chamber by a copper tube which passes through a seal into a stainless steel tube. It is released at the centre of the magnet where an arc is struck between a heated filament and a graphite "snout." The gas is thus ionised, and the ions escape through a hole in the snout where they come under the influence of the magnetic field and the "dee" accelerating electrode.

The filament, which is of tungsten wire $\frac{1}{8}$ in. in diameter, bent into a U and clamped in a chromium-copper holder, is supplied with a direct current of 400 amperes at 4 volts from a motor-generator set. The connection between the motor-generator and the filament holder is through flexible copper straps, clamps and water-cooled copper tubes. These tubes pass through electrically insulated vacuum seals into the stainless steel tube mentioned above, where together with the gas tube they are supported on pyrophyllite spacers, which act as insulators. These spacers also counteract the mechanical forces set up as the filament current passes through the main magnet field.

To enable filament renewal to be effected without opening the main vacuum chamber to atmosphere the stainless steel tube mentioned above slides in a larger tube, so that the filament can be brought out through an air lock. This larger tube, which is fixed half in and half out of the vacuum chamber, is surrounded by a water jacket for cooling the graphite snout, which is mounted at its inner end. The inner tube passes through a bearing and a vacuum seal and is borne externally on wheeled supports and a runway of aluminium alloy. It is thus maintained at the right level for re-entering the outer tube after a filament has been replaced.

FILAMENT ADJUSTMENT

To enable the position of the filament relative to the graphite snout to be adjusted axially a square-threaded nut is attached to the outer end of the inner steel tube. The combined assemblies can also be moved by square-threaded nuts and reversible motors, one of which drives the snout in or out and the other from side to side. The hole in the snout can thus be set at any point within a radius of $\frac{1}{4}$ in. from the vertical centre line of the magnet poles.

As the filament is maintained at a potential of 150 volts to the graphite snout the external connections are protected by aluminium covers, the removal of which disconnects the supply and thus eliminates the possibility of shock when the filament is being changed. A view of the ion source showing the air-lock chamber, electrical and hydraulic connections and in-and-out driving mechanism is given in Fig. 3, while the filament holder and filament and the graphite snout are illustrated in Figs. 4 and 5, on page 213 respectively.

All the materials used in the construction of the ionising equipment, except in the motors, are non-magnetic. Those parts which are installed in the vacuum chamber are arranged so that they will not be damaged by stray bombardment. In fact, the centre line of the stainless steel tubes is about 4 in. above the centre of the magnet gap so that they are not

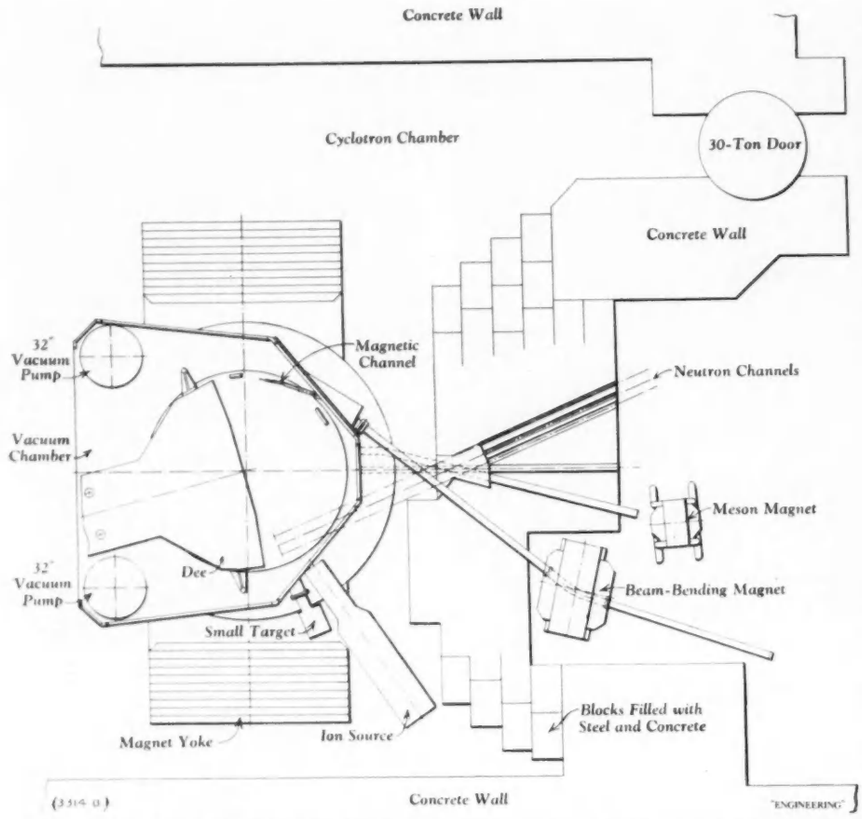

Fig. 2 Plan showing disposition of the synchrocyclotron and some of its associated apparatus.

normally in the path of the accelerating ions. Wilson-type vacuum seals are used.

ROTATING CONDENSER

The radio frequency field is generated by an earthed grid oscillator, the anode of which is supplied from a six-phase bridge-connected mercury-vapour rectifier. The output of this rectifier, which is fully smoothed, is 108 kW at 12 kV; and the maximum radio frequency voltage is 15 kV. This voltage is applied to the two accelerating electrodes in the vacuum chamber, which are known as the "dee" and "dummy dee,". The latter is earthed through a stub line which matches the impedance characteristics of the oscillator. The frequency modulation, which is necessary to maintain the particles in synchronism with the radio frequency potential, is effected by interposing a variable condenser between the feed from the radio-frequency oscillator and the dee accelerating electrode, as shown in Fig. 7. This condenser, which is illustrated in Fig. 6 and Fig. 8, consists of a rotating cylinder carrying six rows of blades, which pass between two rows of stationary blades. One row of stationary blades is mounted on the top of the stub line and the other on the end of the dee line, as shown in Fig. 7, different lengths of stator blades being provided for accelerating the protons and deuterons, respectively. As the mean beam current from the cyclotron is dependent upon the rate of modulation repetition, which should be as high as possible, a rotor speed of 2,000 r.p.m. was chosen, giving 200 frequency sweeps per second. The condenser is driven through a V-belt by a 15 h.p. direct-current motor, which is supplied from a grid-controlled mercury rectifier, a feed-back circuit being incorporated to maintain the speed within $\pm$ 1 per cent. Each bearing block is hung from a pair of thin tubular legs and both they and the shaft are insulated from earth so that a direct-current bias of up to 2 kV can be applied to the rotor. All parts on which there is likely to be any appreciable power loss are water-cooled. As the condenser has to run in a vacuum of less than 1×10^{-5} mm. of mercury it is enclosed in a mild steel tank, which has one side open to the cyclotron vacuum tank and a bottom aperture for the stub line stator blades. To keep the stray capacitance down to a minimum the bearings are installed *in vacuo*, an arrangement which, although it made their design more difficult, facilitated the construction of the rotating seal and enabled the supports approaching the earthed tank [illegible] to be kept small and of high impedance.

The condenser rotor consists [illegible] ten chromium-copper sections 2 ft. in diameter, each of which is made up of six rows of blades with eight blades in a row. The sections are clamped between two stainless steel stub shafts by 12 phosphor-bronze tie bolts, which pass through the whole length of the rotor, as will be clear from Fig. 6. To obtain the maximum capacity and, the greatest possible freedom from spark-over, the gap between the stator and rotor blades had to be very close to the nominal figure of 0·131 in. for protons and 0·072 in. for deuterons. The actual tolerances on each blade are $\pm$ 0·005 in. from a datum face at one end of the complete rotor, conditions which necessitated careful machining. The rotor sections were trepanned out to a diameter of 13 in. and vacuum-tight seals were made between them by Neoprene O-rings.

COOLING AND LUBRICATION

The condenser is cooled by water supplied through concentric tubes in the driving shaft and forced along an annular space between the bores of the rotor sections and a 12¾ in. copper tube which is clamped between the stub-shafts. Even distribution of the water round the annular space is ensured by copper strips which are soldered to the outside of the tube and form helical guides. The water is returned to the shaft through a tube inside the rotor. This construction enables the quantity of water inside the rotor, the total weight on the bearings and any unbalanced forces to be reduced to a minimum. With a flow of 10 gallons per minute the average temperature rise on the rotor bore is limited to about 3½ deg. C.

As a circulating oil system of lubrication might set up a constant air leak and the oil would have to be drained out of the bearings by gravity, "extra light" roller bearings were chosen to carry the rotor load of ¾ ton. This enabled the diameter of the races and rollers to be reduced and the rubbing speeds between them and the cage to be kept down. The bearing housings and shafts are water cooled to remove the heat generated by the electrical losses and by friction. The few drops of oil needed for lubrication are supplied at infrequent intervals by two hand pumps. The oil used for this purpose is a residue left from the distillation of Apiezon "water-white" diffusion pump oil and has been found to give a wear

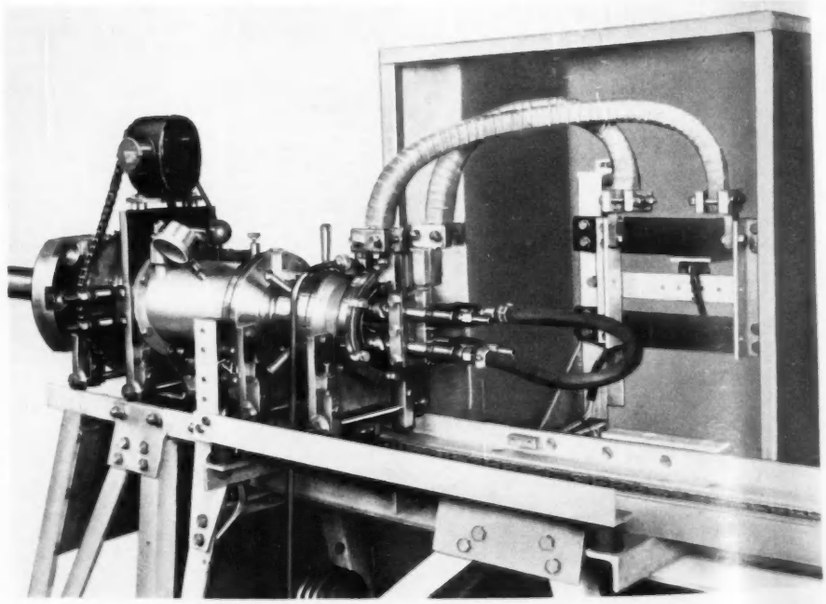

Fig. 3 Ion source, showing the air-lock chamber, the electrical and hydraulic connections and the in-and-out driving mechanism.

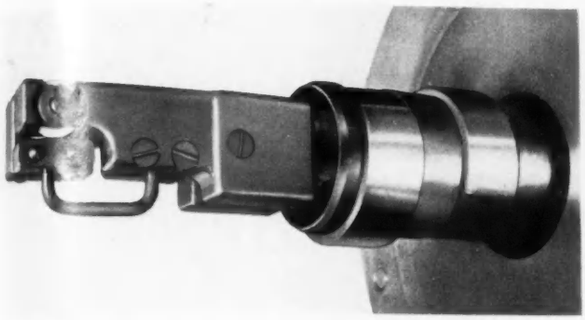

Fig. 4 Filament and filament holder.

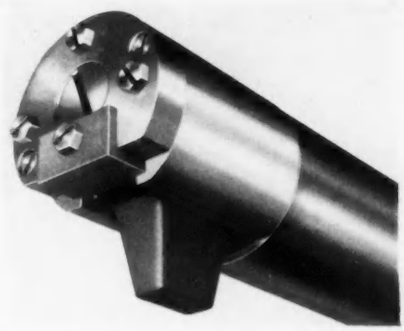

Fig. 5 Graphite snount which is carried on the outer stainless steel tube.

rate of about two-thirds of that of D.T.E. special light turbine oil.

The support legs and drive shaft of the condenser rotor are borne on zircon ceramic insulators, which are shunted to earth through condensers. Both insulators and condensers are enclosed in copper screening cans and, like the other high-voltage insulators on the cyclotron, are cooled by an air blast. To prevent stray radio-frequency currents from flowing along the rotor and up the support legs and causing damage to the roller bearings, each bearing block is provided with brushes consisting of narrow strips of molybdenum, 0·012 in. thick, which make contact with a slip ring on the rotor stub shafts.

The vacuum seal on the drive shaft is made up of two elements between which oil is circulated for cooling purposes. Each element consists essentially of a spring-loaded metal ring, which rubs against a stationary carbon ring.

VACUUM SYSTEM

In the Liverpool synchrocyclotron the accelerating electrode structure, the rotating condenser and the stub line are enclosed in three interconnected fabricated steel tanks with a combined volume of 18,500 litres. These tanks are evacuated by two 32 in. diameter pumps of the three-stage oil diffusion type. Each of these pumps has a baffled pumping speed of 10,000 litres per second with an 8 kW heater and an ultimate pressure of 2×10^{-6} mm. of mercury. They are backed by three 8 in. diffusion pumps, which are connected to a common line. Four Kinney rotary pumps, with a displacement of 50 litres per second, can also be connected to this line through a carbon dioxide cold trap. A separate by-pass pipe connects these rotary pumps to the dee vacuum chamber for pumping the system down from atmosphere. Two of these pumps may be used for this purpose, while the others are backing the diffusion pumps.

The fine-side vacuum valves on the 32 in. pumps use the bottom of the dee vacuum chamber as a seating, the valve plates being moved up and down inside the chamber by air cylinders. Wilson seals are used where the piston rods from these cylinders pass through the top of the dee chamber. Air-operated elbow valves are fitted to the backing side connections of the diffusion pump groups, the remainder of the vacuum valves being worked manually.

To prevent oil vapour from flowing back into the vacuum chambers the three large diffusion pumps are fitted with baffles through which brine is circulated, while the rapid condensation of vapour is assisted by liquid-air thimbles in the dee vacuum chamber. The rotary and diffusion pumps are cooled on a closed-circuit water system, which is designed to dissipate 32 kW with a water flow of 40 gallons per minute. Flow relays are provided on the vacuum pump outlets, which shut the latter down if the water flow is insufficient.

PROTECTIVE ARRANGEMENTS

The vacuum system is locally controlled but, since radiation prevents attendance in the control room when the machine is in operation, it is provided with automatic protection. If the vacuum deteriorates a cold cathode ionisation relay trips the ion source and high voltage rectifier. This relay is normally set to operate at 7×10^{-5} mm. of mercury. The air-operated vacuum valves on the high vacuum and backing sides of the diffusion pump groups are interlocked with Pirani relays to prevent the hot diffusion pump oil from being damaged by the admission of air at too high a pressure. The pressure at various points in the system can be measured by seven ionisation and 13 Pirani gauge heads with ranges from 10^{-7} to 10^{-3} mm. and 10^{-2} to 1 mm. of mercury respectively. Geissler discharge tubes are fitted in the roughing and backing lines to indicate the pressure when pumping down.

This vacuum system is necessary in order to reduce the number of collisions between the particles under acceleration and stray gas molecules and has to cope with air leaks, de-

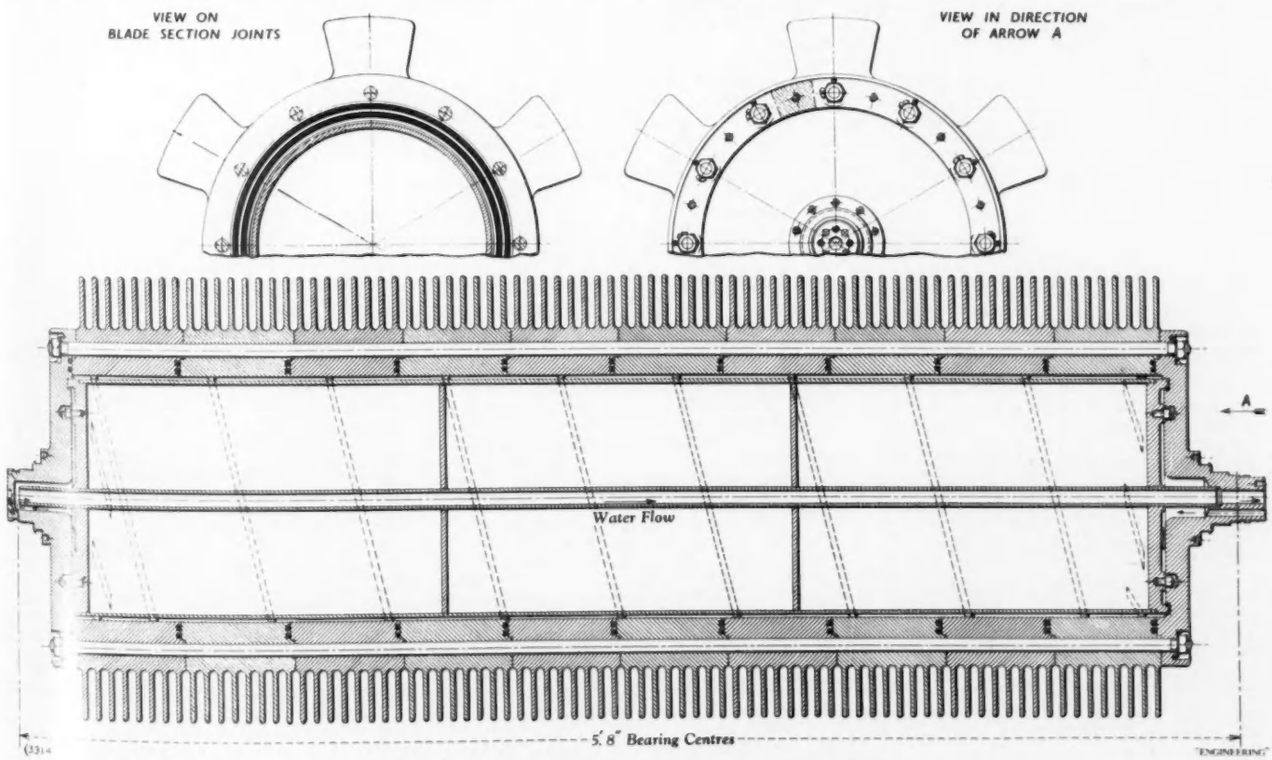

Fig. 6 Rotating condenser—general arrangement of rotor.

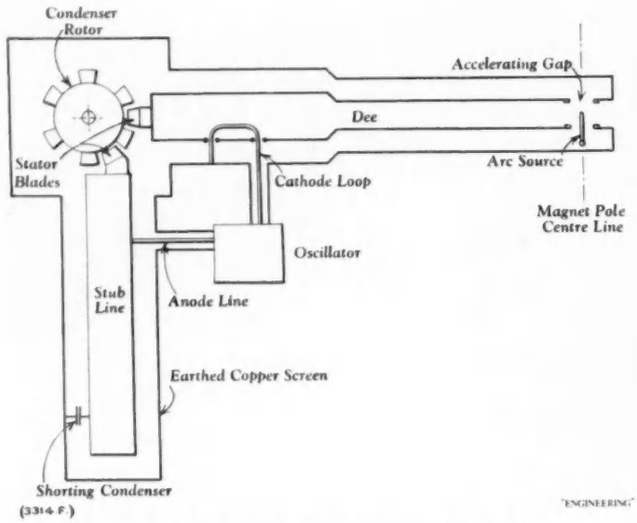

Fig. 7 Diagram of radio-frequency system of synchrocyclotron.

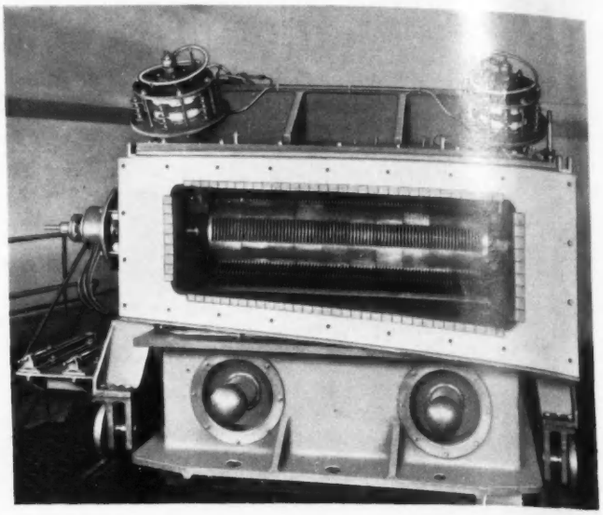

Fig. 8 Rotating condenser withdrawn from "dee" chamber.

gassing from internal surfaces and hydrogen admitted through the ion sources. It enables the pressure in the accelerating region to be kept below 5×10^{-6} mm. of mercury.

MAGNET CONSTRUCTION

The main magnet which forms the most imposing part of the Liverpool synchrocyclotron, is illustrated in Fig. 9. It is 32 ft. wide, 22 ft. high and 13 ft. deep overall. It has a pole diameter of 156 in. with a mean air gap of 14 in. and weighs 1,700 tons. The maximum magnetic field is 19,000 gauss at the centre and is produced by 1,200,000 ampere-turns. Owing to the shortage of special steel, mild steel, which requires a magnetising force of not more than 250 ampere-turns per centimetre to give a flux density of 20,000 gauss, was used.

The magnet was built on site from forged and rolled steel plates supplied by The English Steel Corporation, Sheffield. In spite of its large aggregate weight no plate weighs more than 29 tons. This construction had the advantages that plates were more readily available than large forgings, their magnetic qualities are more uniform and their transport and handling were less costly. The limb plates were machined only on their horizontal edges, the vertical edges being cut by an oxyacetylene flame and the flat sides being left in the rolled condition.

Each stack of plates forming a limb was clamped together by studs and the edges were space-welded. The cylindrical poles were each built up from nine circular plates, which were bolted to the top and bottom limbs. To ensure that the magnetic field in the gap should be as uniform as possible, the pole tips were forged and rolled from a "cheese" cut from the bottom of a large ingot, where the segregation was a minimum. This method of manufacture also ensured that any segregation that might be present would be in the form of annular rings. Any distortion of the flux, which might result, could therefore be corrected when the pole tips were shimmed. In addition, as the carbon content of the steel is less at the bottom of the ingot the saturation density is higher.

ALUMINIUM COILS

After considering the merits of various types of coils from the points of view of reliability and fire risk, as well as of water and oil-cooling, it was decided to use a hollow extruded aluminium conductor, on the grounds of cost. Aluminium, too, can be extruded in lengths which are only limited by the dimensions and weight of the drum on to which it is reeled for transporation, thus reducing the number of joints and the potential sources of coolant leakage.

The aluminium conductor used is 99·5 per cent. pure and was manuufactred by James Booth and Company, Limited, Nechells, Birmingham. Each coil, of which there are two, consists of 26 layers of conductor arranged in 13 pairs of "double pancakes"; and each "double pancake" comprises two flat spiral layers, which are wound from nearly 2,000 ft. of continuously extruded conductor on to a mandrel of aluminium alloy. The conductor is 1½ square inch in cross-section and has a bore 0·65 in. in diameter. The mandrel is built up from a number of rings, each of which accommodates a "double pancake." The coils are connected in series and are insulated with micanite which was treated with Glyptal varnish. The windings and mandrel rings are clamped between two aluminium-alloy end plates by two rings of phosphor-bronze studs. Each coil consists of 494 turns and weighs about 32½ tons. A view of one of the coils on hydraulic test at Trafford Park is given in Fig. 10.

COOLING ARRANGEMENTS

The coils are cooled by passing water through the bore, all the double pancakes being connected in parallel by aluminium manifolds for this purpose. The inlet and outlet connections are of canvas-reinforced rubber hose to provide electrical insulation, and each circuit is arranged so that the water flows from the outside diameter of the double pancake, through one layer to the centre and back through the next layer to the outlet, thus ensuring uniform cooling. The normal flow of coolant through a double pancake is about 4 gallons per minute, circulation being in a closed circuit through water-to-air heat exchangers and the magnet coils. Relays are provided which cut off the direct-current supply to the magnet in the event of the flow falling below a pre-determined rate.

To improve its electrical resistivity (thereby reducing the leakage current that would cause electrolysis and might upset the stabilisation of the magnet) and to reduce the possibility of deposits being formed in the conductor bore, the water is passed through a Deminrolit ion-exchange plant, which was manufactured by the Permutit Company, Limited, Chiswick, London, W.4, and a tower-type vacuum degasser of Metropolitan-Vickers construction, which removes the carbon dioxide gas generated by the de-mineraliser. Mechanical and magnetic strainers are fitted to remove foreign bodies. To prevent the electrolytic corrosion which might occur when two dissimilar metals are in close proximity to water, aluminium was used throughout the system wherever possible. As the employment of other materials could not be entirely avoided, detachable lengths of aluminium conductor were fitted to all the coil terminations in the expectation that any corrosion would be confined to these places.

EXCITATION EQUIPMENT

The magnet coils are excited by an 840 kW 600 volt generator, which is separately excited and is driven by a 1,210 h.p. 6 kV synchronous motor. The generator has a laminated yoke and three field windings—one main and two differential. The main winding can be separately excited from an electronic current stabiliser which maintains the current constant to within one part in 2,500. It can also be excited from a stabilised supply through a hand-controlled potentiometer. One differential winding is connected across the main generator output to give negative feed-back, thereby reducing the effective time constant of the machine by permitting greater initial forcing. The second differential winding is supplied from a metal rectifier, and is used to cancel the residual magnetism of the main generator and the magnet. The output of the main exciter is supplied to the field winding of the generator through a change-over contactor which, when energised, provides a normal forward-field running connection. When it is

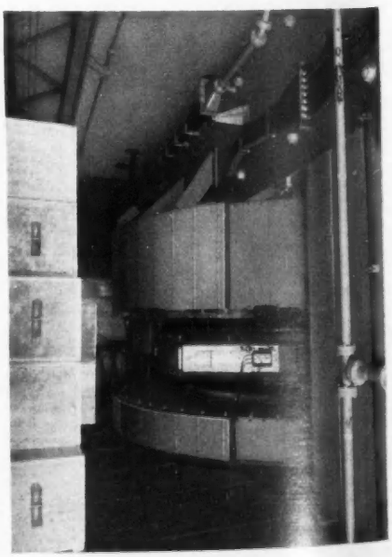

Fig. 9 The coils of the 1,700 ton magnet which forms part of the synchrocyclotron, showing electrical and hydraulic connections.

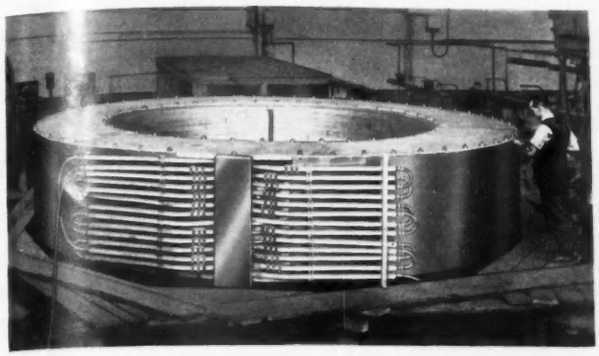

Fig. 10 One of the magnet coils on hydraulic test at the Trafford Park Works.

de-energised, however, the generator field is reversed across its own armature, so that the voltage of the latter is rapidly forced down and held at zero. No electromotive force is therefore generated and the magnet current decays naturally, being damped by the resistance of the magnet and generator. An instantaneous over-current relay trips the change-over switch in the event of faults occurring.

TARGET HOLDERS

Two non-magnetic target holders are provided on the equipment and are arranged so that they can be placed at varying distances from the magnet, and their centres thus bombarded at different energy levels. The smaller holder is for carrying light targets, which are fastened to a non-magnetic steel plate. This plate can be slid into a holder on the end of a stainless steel tube which passes into the vacuum chamber through a bearing and a Wilson seal. Axial movement of this tube enables the target to be inserted into or withdrawn from the magnet gap either by a chain and hand wheel or electrically through gearing. A clamp holds the tube in any position against the pull of the vacuum. The target is removed by drawing the holder into an air-lock in the side of the main vacuum tank. This chamber is then let up to atmosphere by closing a sealing door of the flap-valve type, so that the tube, the port through which it passes and the target holder can then be pulled out further. As the distance between the air-lock chamber and the magnet yoke is too small for the target tube to be withdrawn in one piece it is made in three sections which can be screwed together on O-rings to ensure vacuum tight joints. The small target holder can also be fitted with a "neutron stripper," which will enable a beam of neutrons to be brought out through an aluminium window in the main vacuum chamber.

The large target holder, has been designed for loads up to 500 lb. It is moved into the magnet gap in the way just described. Owing to the limited space available between the main vacuum chamber and the yoke part of its air lock chamber is re-entrant and has a sliding door. In order that this door can be withdrawn without obstructing the passage of the target holder and so that it shall make a vacuum seal when closed, a lead screw is used to push it across the opening. This door also brings a thrust bar across with it, until the latter notches into the side of the air-lock chamber. Further pressure from the lead screw releases a spring-held toggle which forces the door forward to make a vacuum seal. Access to the target, when withdrawn, is given through cover plates on the exterior of the air-lock chamber. The target tube can be moved axially by a lead screw which is electrically driven through gearing and can be operated either locally or from the control room to which the target position is transmitted electrically.

BEAM BENDING MAGNET

The proton beam having emerged from the cyclotron is bent and focussed by a 14 kW mobile water-cooled electromagnet, which is designed to give a vertical magnetic field of more than 13,000 gauss in a 3 in. air gap between plane parallel pole faces. The air gap can be reduced to 2·08 in. in $\frac{1}{16}$ in. steps by removing shims from the interfaces of the yoke. Adjustable semicircular extension pieces are fitted to the pole faces for bending the beam.

The magnet, which weighs about 10½ tons, is mounted on a six-wheel bogie, two of the wheels being set lower than the others to facilitate rotation. The gap height is adjusted by four screw jacks, one at each corner of the bogie. Each pole carries six double-layer coils which are formed of hollow aluminium conductor through which cooling water is circulated. All 12 coils are connected in series, giving 504 turns and a resistance of about 0·45 ohms. With the normal excitation of 176 amperes the magnet provides 89,000 ampere-turns, the mean temperature rise being 13 deg. C. for a water pressure of 5 lb. per square inch.

The cooling system has, however, been proved to be highly efficent and higher flux densities could be obtained from the same design by increasing the magnetisation.

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AIR-CONDITIONING PLANT

Industrial Units for Offices and Stores

Two industrial air conditioning units now being made by Brentford Electric Limited, Kidbrooke Park-road, Kidbrook, London, S.E.3, both utilise the heat-pump cycle for their operation. The first, shown in the illustration, is designed to be built into a wall of the building, or alternatively into a window frame, and is known as the "Twin-air" unit; the second, designed as a free standing cabinet, is called the "Thermokoolair." The latter also supplies hot water.

The Twin-air unit has an average coefficient of performance of 4 at 40 deg. F. and 80 per cent. relative humidity. Two sizes are made with ratings of ¾ and 1 h.p. The respective intake capacities are 55 and 80 cub. ft. of fresh air per minute, with air circulation of 550 and 650 cub. ft. per minute; that is to say, approximately 90 per cent. of the air handled is recirculated and the remainder drawn from outside. The recirculated air is drawn through inlet grills on the cabinet and passes over the "indoor" coil of the machine. In doing this it is either heated or cooled (for the unit is reversible according to the ambient temperature), dehumidified and returned to the room. Condensed vapour is ducted to the outside. Two fans are incorporated, one indoors and one out, the former having a very low noise level. The compressor unit is resiliently mounted to reduce noise.

CELLAR COOLER AND WATER HEATER

The heating capacities of the two sizes are approximately 12,000 and 15,000 B.Th.U. per hour and the cooling capacities 8,500 and 10,800 B.Th.U. per hour, when the cycle is reversed. If desired, an additional booster heater can be fitted for use when the outdoor temperature falls much below freezing point. This heater is a 2 kW unit of the dull emission type. The casings are made of aluminium alloy throughout, and are both acoustically and thermally insulated. The smaller size is recommended when the volume of air to be conditioned is approximately 4,500 cub. ft. and the larger for a volume of 5,500 cub. ft.

The second of the two models, the Thermokoolair, is specifically designed for the cooling of cellars, dairies, stores and similar buildings. It transfers the heat extracted from the air to a tank of water, which can be piped up to wash basins, etc. The tank has a capacity of 32 gallons, is made of copper and conforms to B.S. 699/1951; it is fitted with connections for 1 in. B.S.P., and is insulated with a 3 in. layer of cork. Two sizes of the unit are made, both measuring 24 in. square by 56 in. high, one being rated at ¼ h.p. and the other at ½ h.p. The cooling capacities are 3,000 and 3,500 B.Th.U. per hour respectively and the amount of hot water which each will supply is 110 and 140 gallons per day at 140 deg. F. They are quiet in operation and will run in ambient temperatures up to 80 deg. F.

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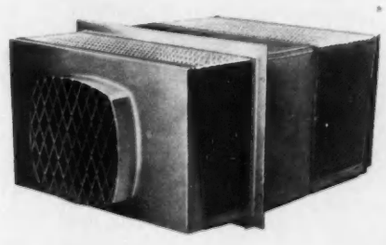
THERMAL EFFICIENCIES OF BRITISH POWER STATIONS

A Continued Improvement

The Central Electricity Authority announce that the overall thermal efficiency of their steam stations during 1955 was 24·14 per cent., compared with 23·71 per cent. for the previous year. This represents a saving of 720,000 tons of coal and nearly £2½ million in cost. Of over 68,340 million kilowatt-hours sent out from the steam stations during the period, almost one-third was provided by the 20 most efficient stations operating throughout 1955. These 20 stations had an average efficiency of 28·53 per cent., their individual figures being set out below:

Station	Thermal efficiency Per Cent.
Littlebrook B, Dartford, Kent	30·37
Stourport B, (low pressure), Worcs.	30·32
Dunston B II, Newcastle-upon-Tyne	29·39
Barking C, London	29·29
Bromborough, Cheshire	29·04
Skelton Grange, Leeds	29·02
North Tees C, Middlesbrough	29·01
Brunswick Wharf, Poplar	28·87
Keadby, Scunthorpe	28·70
Uskmouth, Newport, Mon.	28·55
Brighton B	28·52
Poole	28·30
Carrington, near Manchester	28·29
Deptford East (high pressure), London	28·19
Littlebrook C, Dartford, Kent	28·10
Battersea B, London	27·89
Huncoat, Accrington	27·78
Carmarthen Bay, Burry Port	27·71
Chadderton B, Oldham	27·51
Staythorpe, Newark	27·25

Five other stations which did not come into operation until after January 1, 1955, but nevertheless recorded high efficiencies during the period they were working, were: Drakelow, Burton-on-Trent, 30·90 per cent; Stourport B (high pressure), 30·42 per cent.; Stella South, near Newcastle-upon-Tyne, 29·66 per cent.; Stella North, 29·22 per cent.; and Ince, near Ellesmere Port, 28·97 per cent.



The Twin-air air-conditioning unit is designed to be built into a wall or window frame. It is reversible and so can either heat or cool the room.

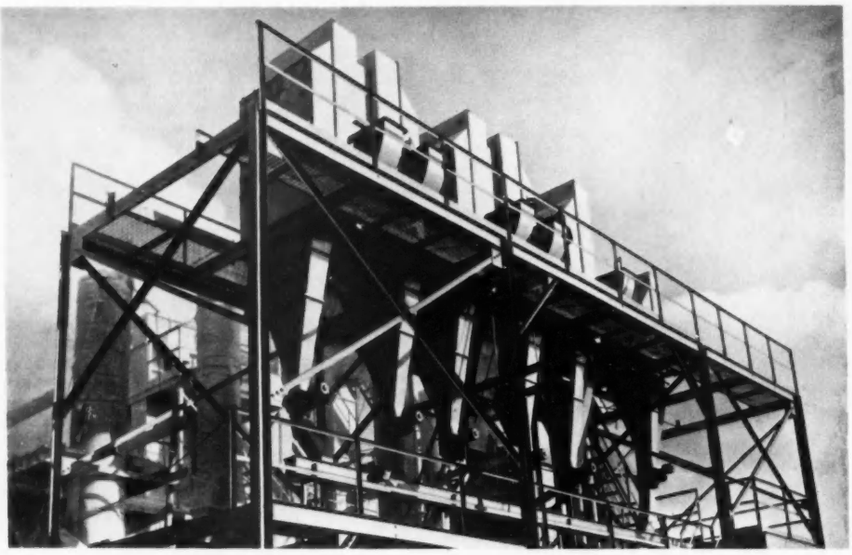


Fig. 1 The extraction of dust is frequently a major problem in a large works. Here a set of six 252-tube units operating on the centrifugal principle is being erected.

REMOVAL OF DUST

SCOPE AND APPLICATION OF CYCLONES

The menace of industrial dusts has been realised for a very long time, but it is only of comparatively recent years that large scale action has been taken to reduce it. In earlier days it was regarded as one of the natural hazards of an occupation, but the growth of industrial welfare has caused a change in outlook. Methods are now available for dealing with dust particles of almost all sizes and types, and the installation of collecting apparatus is now regarded as essential. The risk from dust is not only the direct one of inhalation, but also many materials when very finely divided are liable to give rise to violent explosions.

The choice of method used for the collection must depend on the nature of the dust involved; some are readily removed by filtration, others by electrostatic precipitation, and others can be most easily dealt with by centrifuges or cyclones. This article is concerned chiefly with the last type, in the forms manufactured by Mancuna Engineering Limited, Denton, Manchester, who are makers of all types of air conditioning and dust extraction equipment.

The chart, Fig. 3, shows the range of particle sizes normally encountered, and gives data concerning their occurrence, measurement and method of separation. In addition, comparative screen sizes, laws of settlement and a spectrum comparison are given. It will be seen that cyclones of various types can be used efficiently for all sizes down to about 4 microns, filters to about 0·1 micron and electrical precipitators from 10 microns downwards. Some dusts, however, lack the high dielectric constant needed for electrical precipitation, the capital costs of which are high but may be offset in some cases by recovery of the dust. Wet filters are highly efficient over a fairly wide range but are largely confined to eliminating nuisance dusts, as recovery is extremely difficult, while sludge disposal can also present a problem. Cloth filters tend to increase in resistance as the fibres fill up and they have the additional disadvantage that they are very difficult to clean.

Centrifugal separators of the cyclone type can be subdivided into unit cyclones and multicyclones; the former are probably the most common type of dust collector in use and can work at a very high grain loading, that is a high concentration of dust. Their efficiency within the micron range, however, is poor, and their main use is as primary collectors for the larger particles. Low in capital cost, their running and maintenance costs are negligible. Multicyclones consisting of a large number of small units in parallel and operating under closely controlled conditions can be highly efficient in the 200 to 5 micron range at fairly low grain loadings. Capital cost is not high and running and maintenance costs are small; they are not subject to fire hazard and can be easily cleaned.

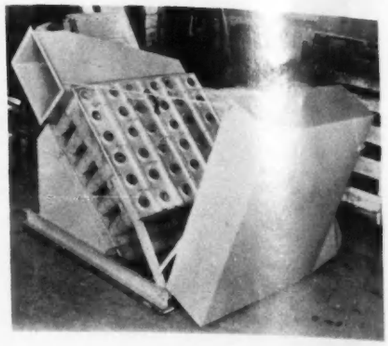


Fig. 2 The standard Microclone unit is made up of 36 tubes. The lifting cover gives easy access for cleaning.

PRINCIPLE OF THE SMALL CYCLONE

The cyclone, as is well known, separates the dust by using centrifugal force, and therefore the specific gravity and terminal velocity of the particles govern the separating characteristics of any given dust. When dust-laden air enters a

TABLE I. FIELD TEST FIGURES FOR VARIOUS MATERIALS

Material	Operating temperature, deg. F.	Pressure drop, in. of water	Unit efficiency, per cent.	Overall plant efficiency, per cent.	Remarks
Urea formaldehyde ..	203	6·6	93	99·9	As secondary to unit cyclones on spray drier
P.V.C.	142	3·5	99·9	99·9	
Putty whiting ..	122	6·0	84·5	84·5	87 per cent. below 5 microns
Provender (grinding mill)	70	6·2	99·5	99·5	Mill exhaust
Flour dust	70	6·0	99·9	99·9	Mill exhaust
Coffee	188	5·75	99·8	99·8	Spray drier exhaust
Foundry knockout ..	70	6·5	98	98	
Ammonia sulphate ..	155	6·0	99·3	99·3	

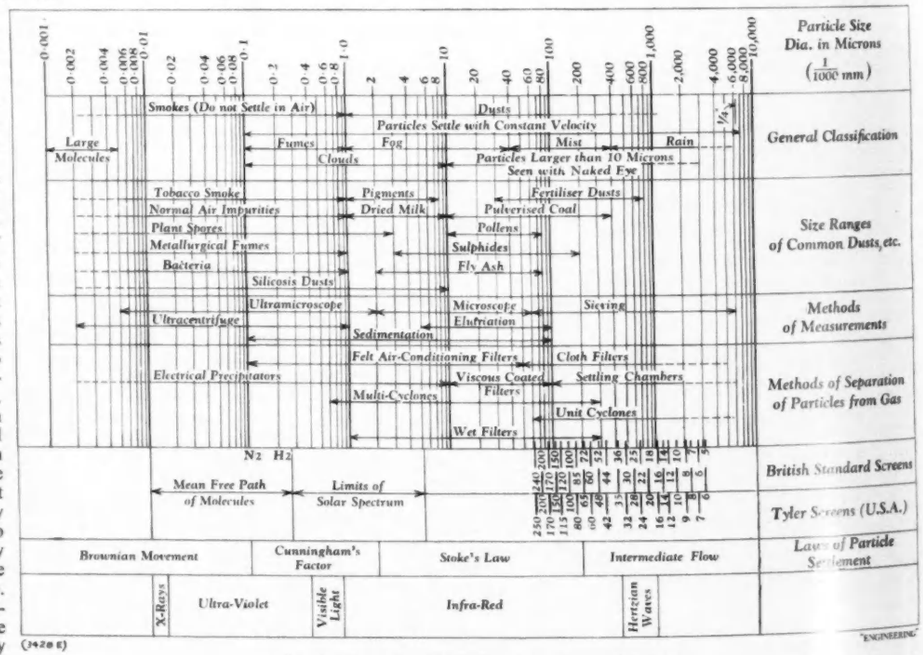


Fig. 3 Particle size comparison chart with data.

cyclone the smaller the radius through which it is turned, the higher the centrifugal force exerted on any solid matter in the air. However, no practical use can be made of this unless a large number of small units can be assembled together. This introduces a difficulty in the design of the manifold, as each cyclone tube must receive the same quantity of air at the same pressure, and with an equal distribution of material. If this is not so, the overall collecting efficiency would be poor, and clogging might occur in some of the units. The air passages through the unit are also naturally small, and must be so shaped that they are continuously swept by the air-stream at full velocity. Any eddying would cause a deposit of dust and consequent clogging.

The second problem is to find the operating velocity which will separate a given dust without clogging and with the minimum pressure difference across the cyclones. Proper provision must also be made for cleaning.

The Mancuna-Microclone collector, which is an assembly of a number of small cyclones, is aerodynamically balanced to give equal pressure at each cyclone tube. An example of one of these units is shown in Fig. 2 with the cover raised for cleaning. All the passages are polished, and the unit can be made of aluminium or stainless steel. The design has been chosen to cater for organic dusts so that frequent cleaning can be carried out easily and efficiently. The precipitating sections and the cover are made of a cast aluminium alloy; the outlet pipes are standard in steel or aluminium. Special units can be made in stainless steel if required. The housing, inlet and hopper are of low-carbon steel.

The Dustex collector operates on a controlled helical flow principle. An example containing 224 tubes is shown in Fig. 4, and a set of six 252-tube units is shown in Fig. 1 during the course of erection at the National Lime and Stone Company's works at Carey, Ohio, U.S.A. The inlet manifold feeds the individual tangential cyclone inlets at a constant pressure without eddies. The construction is in heavy-gauge mild steel and the standard unit will operate at high temperatures. Stainless steel units can also be supplied. The individual inlet removes the possibility of blocking or piling up of fibrous or agglomerating materials.

TEST SAMPLES

Before the installation of any dust collecting apparatus is made, samples should be taken of the dust concerned to determine its grain size, specific gravity, terminal velocity, particle shape, and the agglomerating, hygroscopic and chemical properties. In addition, site conditions of grain loading, operating temperature range and operating humidity range must be recorded. To obtain these data a specialised form of test equipment is used. Random samples are seldom truly representative and a particular technique is required to give accurate results.

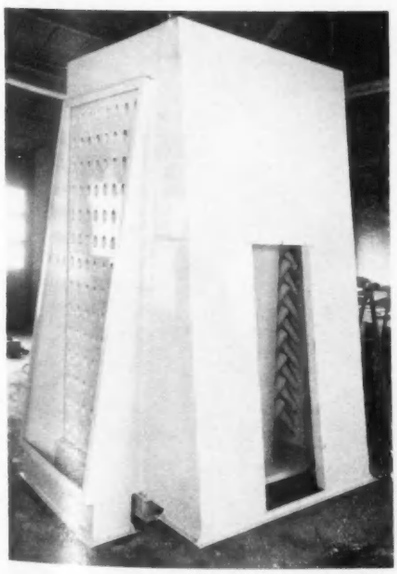


Fig. 4 224-tube Dustex unit of the type used in Fig. 1, of which Air entry is through two ducts, one on the left (shown with cover removed).

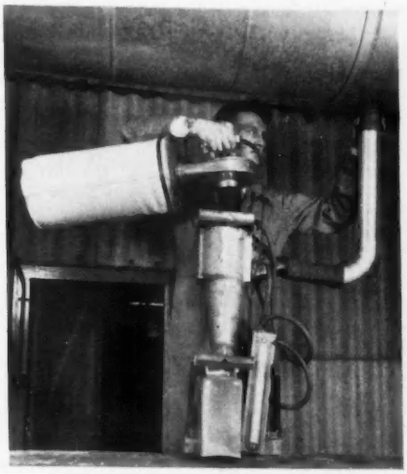


Fig. 5 In order to determine the size of extraction plant required, accurate sampling must be carried out. A single-tube unit is used with the pressure drops adjusted to be comparable with a multi-tube set.

Two types of test equipment are normally used by Mancuna, which can be attached to an existing plant and will operate under the same conditions as the final full-scale plant. The first is a single-tube set, which consists of a tube mounted on a fan and fitted with balancing valves on the inlet and outlet, a manometer for indicating the pressure, a glass jar to receive the extracted dust and a heavy close-woven felt bag to catch the carry-over dust. Such a test set is shown in Fig. 5. The first operation is to take Pitot-tube readings of the velocities in the duct with the plant in normal operation. The pick-up orifice of the tube inlet is then adjusted to give the same velocity in the tube as in the duct. The pressure drop across a sectional tube varies considerably from the operational pressure drop across a multi-tube unit, and this is converted by a table to obtain the operating pressure of the test unit. Both jar and bag are accurately weighed before and after the test. The set is then run for a fixed time and the results tabulated. The sample extracted is taken to the laboratory, where the grain loading classification is determined as to size, group and agglomeration. Lastly, visual tests are run at varying pressures and with controlled temperature and humidity, to ascertain the conditions which will cause build-up and subsequent clogging, and also the maximum grain loading that can be tolerated.

Tests are carried out over a wide range of conditions and from the tabulated results the final plant is designed. Having determined the limits it is essential for efficient operation that they shall be maintained on the full scale plan. If it is not possible to maintain the limits, and efficiency cannot be sacrificed, ancillary equipment must be provided to deal with the overload. The procedure with the multi-tube test unit is similar. Field results for a selection of dusts are given in Table I. These have been chosen to show the wide range of materials which have to be handled by dust extraction plant. Other applications include the collection of cadmium/tin alloy dust in a selenium, and the subsequent recovery of the material which is a comparatively costly one. In a rather different field is the recovery of tri-ethylene glycol from the mist carried over from the concentrator.

DETECTING AND REMOVING TRAMP METAL

Economy of Combined Machine

Magnetic removal of tramp iron from bulk material being conveyed by various means is a well-established practice. Electronic detection of metals, though a newer development, is also well known in industry. Metal Detectors, Limited, Moseley-street, and Rapid Magnetic Machines, Limited, Lombard-street, both in Birmingham, 12, are now collaborating to provide magnetic extraction of tramp iron, controlled by an electronic detector.

The arrangement uses a detector search-coil at some distance back from the magnetic extractor. This coil detects iron passing along the conveyor, and signals its presence to a control unit and rectifier panel, by which means the excitation of the magnet windings is controlled. Maximum saturation therefore takes place only when a large piece of iron is encountered, the temperature rise of the magnet windings is minimised, and current consumption is lowered.

A secondary detector, mounted beyond the magnet, acts as a gleaner, and stops the conveyor to enable non-ferrous metals to be removed.

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CONDUIT BENDING

A bending machine for conduit which can be bolted to a work-bench, held in a vice, or mounted on a portable stand, is now being made by Hilmor Limited, Caxton Way, Stevenage, Hertfordshire.

The stand-mounted model is shown in the accompanying illustration. The bending is carried out by a screw-operated ram to which formers can be attached to suit the size of tube being bent. A loose pin dropped into a stop hole marks the end of the tube for bending, and a degree stop mounted at one end gives control of the angle. The capacity of the machine is, for gas and steam pipes, from $\frac{1}{4}$ in. to 1 in. nominal bore, and electrical conduits from $\frac{5}{8}$ in. to $1\frac{1}{2}$ in. outside diameter. A ratchet spanner can be fixed to the end of the screw to apply the necessary force. Second bends can be made at any angle relative to a primary bend, and directly adjacent to it as the working area is free of projections.

Operated by a screw ram, the bending machine can be mounted on a portable stand as shown, or bolted direct to a bench.

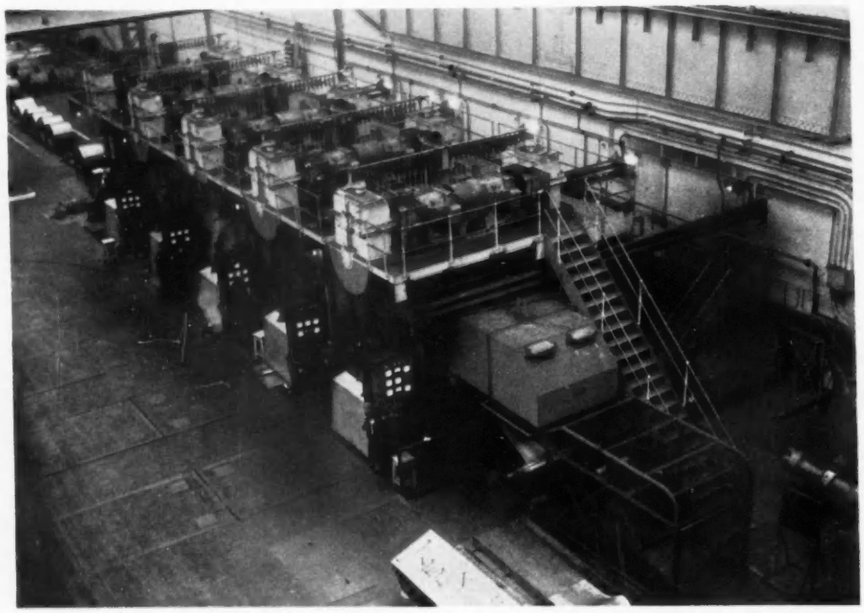

Fig. 1 Exit end of the new five-stand tandem cold-reduction strip rolling mill now in production at Ebbw Vale Steelworks, viewed from above. The strip rolled ranges up to a maximum of 38 in. in width. The maximum in-going thickness is 0·14 in. and the minimum out-going is 0·006 in.

COLD STRIP ROLLING MILL AT EBBW VALE

FINISHING SPEED OF 5,000 FT. PER MINUTE

Erected as part of a £12 million scheme for the development of the iron-making, steelmaking, and tin-plate production plant at the Ebbw Vale Steelworks of Richard Thomas and Baldwins Limited, a new five-stand tandem cold-reduction strip rolling mill has recently been brought into production. It replaces an original five-stand mill of American manufacture which had worked continuously for 17 years from 1938.

THE NEW ROLLING MILL

A general view of the new mill is seen in Fig. 1. It has been erected at a cost of about £3 million by Davy and United Engineering Company Limited, Sheffield, and has been designed for very fast operation, its finishing speed being 5,000 ft. per minute. Each stand consists of two 21 in. diameter alloy-steel forged work rolls and an upper and a lower cast-steel backing-up roll each having a diameter of 53 in.; the length of the rolls is 42 in. The strip rolled ranges in width up to a maximum of 38 in., the in-going gauge having a maximum of 0·14 in. and the out-going a minimum of 0·006 in. Welding equipment recently installed on the continuous hot-rolled strip pickling lines allows coils to be built up to 36,000 lb. in weight. This is the maximum the new mill is capable of handling, in contrast to the single coils of 9,000 to 10,000 lb. previously rolled. On the score of output, the new mill can produce at least 8,000 tons of tin-plate-quality strip in a week but a considerably higher weekly tonnage than this can be expected when the plant is brought up to full production. Outputs of the order of from 9,000 to 10,000 tons a week are regarded as well within the bounds of practical rolling possibilities.

The ten housings supporting the five stands of the mill are one-piece steel castings each having a post area of 870 sq. in. and weighing 93 tons. The stands of the mill are spaced at 13 ft. centres with the pass line established at the convenient operating height of 36 ft. above the mill-floor level. The work rolls are carried in Timken four-row taper roller bearings of balanced proportion type. The backing-up rolls rotate in oil-film Morgoil bearings supplied by the Morgan Crucible Company Limited, and carried in cast-steel chocks.

Incoming hot-reduced coils are loaded by floor trucks on to a 33 ft. long power-driven slat conveyor which has a capacity of four coils each of 36,000 lb. and an operating speed of 20 ft. per minute. From the conveyor, coils are passed one at a time on to an entry ramp; the coil is centralised and the "tail" of the strip fed into the first stand of the mill through a heavy-construction entry guide. Between each stand of the mill single-roll tensionmeters are fitted to allow of the measurement of inter-stand strip tension. Situated at the delivery sides of both stands No. 3 and 4 are double holding-down rolls working in conjunction with the tensionmeters and serving a dual purpose. The first function of these rolls is to steady the strip and damp out any vibration and also to control the "whip" of the tail end of the coil as it leaves the preceding stand. The second function is to spread the palm oil sprayed on to the strip at these points and, to meet this requirement, the roller sited nearer to the mill stand is spirally grooved to give speedy rough spreading of the oil. The following second roller has a plain surface to give even spreading. Other inter-stand fittings include spray banks between all the stands for applying roll-cooling water and palm oil to the strip and a complete Visco fume extraction system which removes all obnoxious fumes from the operating stations at the rate of 120,000 cub. ft. a minute. Water for cooling the rolls during operation is sprayed at the rate of 4,000 gallons a minute.

STRIP-COILING MECHANISM

On exit from the last stand the strip can have its gauge checked by a flying micrometer situated between two deflector rolls which maintain a constant pass-line for the strip to ensure accurate reading. The strip is then coiled on an overwinding tension reel, the initial laps being assisted by a retractable reel entry guide and a wrapper of the twin-belt overwinding type which is traversed up to, and away from, the reel by a hydraulic cylinder.

The tension reel, seen in Fig. 3, is of the concentrically expanding type, having a diameter of 20 in. when expanded. It is driven by a direct-coupled 900 h.p. motor. At the conclusion of its build-up the coil is stripped from the reel by a hydraulically-operated stripping carriage. After a lateral traverse to clear the reel, the coil is automatically ejected sideways on to a delivery conveyor via a single-stop delivery ramp. The delivery conveyor, like that on the entry side of the mill, is of the power-driven slat type built by Bagshawe and Company Limited. It is 29 ft. 3 in. long, has a speed of 30 ft. per minute and has a capacity for five 36,000 lb. coils. Built into the conveyor is a hydraulic lifting mechanism which raises the coil clear of the conveyor and enables its weight to be recorded on an adjacent Avery scale.

Two electro-hydraulic control desks, situated at the entry and delivery ends of the mill, govern the numerous motions required for the operation of the various units of auxiliary equipment provided for the mill.

The new rolling mill is worked by eight men, with two more men acting as stand-by operators.

ELECTRICAL EQUIPMENT

The high rolling speeds employed demand driving power of equivalent magnitude, and the total horse-power applied to the mill is 19,150. This electrical equipment has been supplied by the English Electric Company Limited. Direct-current motors drive the five stands and the coiler and a general view of these is seen in Fig. 2. The motors are supplied from two 11 kV 9,000 h.p. synchronous motor-generator sets. All machines are force-ventilated and flood-lubricated and each stand drive has its own separate generator. The rolling-mill stands are driven by direct-coupled motors, through a pinion stand and spindles, the latter being spring balanced in the case of Nos. 1, 2 and 3 stands and hydraulically balanced at stands Nos. 4 and 5, where the higher spindle speeds have to be reckoned with. The motor ratings, powers and speeds are as given in Table I, opposite.

The electrical equipment is maintained cool and clean by a forced-air ventilation system supplied by Heenan and Froude, Limited. In this the warm air from the electrical machines is

Fig. 2 Motor room, showing the main drives for the five stands and tension reel. These total upwards of 19,000 h.p. The machines are flood-lubricated and force-ventilated on a re-circulating system. The commutators are naturally ventilated.

Fig. 3 A coil of strip being built up at speed on the out-going tension reel.

passed through tubular air coolers and discharged into a basement where fans re-circulate the cooled air back to the machines.

SCREW-DOWN GEAR

The rolling-mill screw-down gear which is built into the roll housings consists in the case of each stand of two 50 h.p. motors running at

TABLE I

Rolling-Mill Stand	Motors			Rolling-Mill Speed (ft. per min.)
	No.	H.P. of each	R.P.M.	
1	One	1,750	90–225	495–1,400
2	Two	1,750	125–304	688–1,667
3	Two	1,750	200–445	1,100–2,440
4	Two	2,000	350–645	1,930–3,550
5	Three	1,834	500–910	2,750–5,000

between 550 and 1,650 r.p.m., coupled by a 24 in. diameter magnetic clutch, driving double-reduction gears and worm gears of 1,000 to 1 total ratio to give screwing speeds ranging between 0·22 in. and 0·66 in. per minute.

A particular feature of the screw-down gear is that the conventional involute-tooth worm and wheel have been replaced by a cone worm and wheel of the double enveloping type. It is claimed for the cone worm that it has large instantaneous contact per tooth and also multiple tooth contact, resulting in greater load-carrying capacity at lower unit pressures.

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SEALING STEAM LEAKS QUICKLY

A leak of steam from a system is a constant source of expense, besides being a nuisance. Indeed it has been calculated that steam at 300 lb. per square inch escaping through a hole ¼ in. in diameter represents the loss of 130 lb. of coal a day, or approximately 4s. 8d. Yet it is often extremely inconvenient to shut down a plant to mend only a small leak.

To meet such a situation, the "Furmanite" process has been developed by Metalock (Britain) Limited, 68, Grand Buildings, Trafalgar-square, London, W.C.2. The compound, which is thermo-setting, is injected down a bolt or between the flanges of a leaking joint, against the internal pressure, and hardens within half-an-hour, to form a seal claimed to last ten years. The whole operation takes a matter of a few minutes and is carried out by one man using the kit supplied.

"HYPOWERMATIC" PRODUCTION MILLING MACHINES

An Addition to the Cincinnati Range

A new series of horizontal production milling machines, the "Hypowermatic", has been added to the range made by Cincinnati Milling Machines, Limited, Woodlands Farm Road, Tyburn, Birmingham, 24. The new design of machine is available with single or duplex heads, each type being made in 42 sizes, from 36 in. to 168 in. table travel. In general construction the machine is heavy and powerful, with spindle speeds up to 2,000 r.p.m. and spindle drive-motors up to 50 h.p., according to the size of the machine. It is designed for either conventional or climb milling, with high-speed steel or cemented carbide cutters.

The machine is built on to a heavily-ribbed bed with large chip compartments at each end. Chip-wipers are attached to the underside of the table, and chips can be cleared away without interfering with the operation of the machine. The table travels on square ways, with taper gibs for adjustment. The bed ways are hardened and ground on machines with table travels of over 60 in.

Table drive is by conventional rack with dual pinions driven by a pair of worm wheels and a worm; the latter takes its drive from a hydraulic motor. The complete drive is enclosed within the bed, where it is protected from dirt and damage. Infinitely-variable table-feed rates from ¼ in. to 100 in. or 150 in. (according to the machine size) are obtainable through the hydraulic motor, selection being through a feed-rate dial at the front of the machine. Anti-friction bearings and automatic pressure lubrication are provided on the drive unit, and there is a built-in backlash-eliminating device.

SPINDLE SPEEDS CHANGED BY PICK-OFF GEARS

Sixteen spindle speeds are available, the ratio between the highest and lowest being 40 to 1. Actual speed ranges vary according to the size of the machine; 30 to 1,200 r.p.m. is typical. Speeds are changed by a combination of pick-off gears and a lever-operated back gear. Power to the spindle is by direct-drive through short, heavily-proportioned shafts mounted in adjustable anti-friction bearings. Quick, positive starting and stopping of the spindle are controlled through two hydraulically-operated clutches. Vertical adjustment of the spindle carrier is over wide, square, gibbed ways; a built-in hydraulic counter-balance facilitates raising and lowering of the carrier. Cross-adjustment of the spindle and cutter is through quill construction of the spindle.

All the controls are grouped at the front of the machine, on the right-hand side of the bed. A single lever, with three operating positions, starts and stops the spindle drive. In its third, or "automatic" position, the lever engages the spindle stop, and the spindle only rotates when the table is moving at a feed rate. A second lever, with four directional positions, controls the table feed and rapid traverse, the latter being from 200 in. to 300 in. per minute according to machine size. Manual starting and stopping of the table is by means of a third lever, which is also used to interrupt the automatic table cycle at any desired point. A push-button panel located close to the control levers has "start" and "stop" buttons for the main drive and a three-position switch controlling the coolant pump motor. This switch enables the motor to be run continuously, or to be linked to the spindle operation and run only when the spindle is rotating.

Numerous automatic table-feed cycles can be set by means of trip-dogs mounted adjustably on the side of the table. A typical cycle would be: start, rapid advance table, feed table, automatic reverse, rapid return table, stop. A small modification to the setting would enable the machine to be operated continuously, one cycle following another automatically. By a different setting of the trip dogs the cycle could be: start, rapid advance, feed, rapid advance, feed, automatic reverse, rapid return, stop. Many other cycles are possible.

Lubrication of the principal units is completely automatic, a safety switch and float being incorporated to stop the main motor in the event of the oil level in the reservoir falling below a set low limit. The hydraulic and electrical equipment are in accordance with the appropriate British Standard Specifications. The machine is supplied as standard with electrical equipment suitable for 3 phase, 50 cycle, alternating current of 220 to 550 volts. Equipment to suit other electrical supplies, including direct current, is available to special order. Numerous extra fittings can be supplied.

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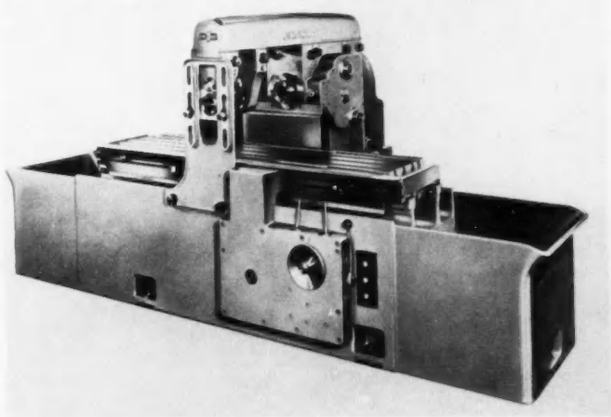
WELDING AND CUTTING

Technical Service Started

The new Sales Technical Service department at the Cricklewood, London, N.W.2, premises of British Oxygen Gases Limited was officially declared open recently by Sir Frederick Handley-Page. The department includes a training school, and Sir Frederick emphasised how much the future depends on adequate training being given to-day.

In addition to the welding training school already noted (which will be attended by both employees of the company and by students from other firms), there is a demonstration shop containing examples of the latest welding and cutting machines. There are also a cutting shop, where customers can see demonstrations of cutting and gouging, including a blowpipe for cutting steel up to 50 in. in thickness, and a process development shop where automatic welding machines and flame hardening can be shown.



The Cincinnati "Hypowermatic" production horizontal milling machine is available with single or duplex heads and in 42 sizes, from 36 in. to 168 in. table travel.

ATOMIC ENERGY EVENTS REVIEWED

REACTOR DEVELOPMENTS AND COMPANY PLANS

The growth of nuclear technology proceeds at such a pace that few weeks pass without the occurrence of some major development. Since January, for example, several firms have announced their intentions to work together in groups on nuclear-engineering projects and progress on a number of research reactors, including one using liquid-metal fuel, has been reported. Various items of nucleonic equipment have become available and announcements have been made concerning the distribution of uranium and heavy water. Other topics which have received prominence during the period are international co-operation on the development of atomic energy in Europe, the use of nuclear power in locomotives and aircraft, and the application of radiation techniques to the problem of cutting-tool wear.

Company Plans.—On February 14, Mitchell Engineering Limited, of London and Peterborough, and A.M.F. Atomics Incorporated, of New York, announced joint plans for the design and construction of nuclear power plants in the Commonwealth and other countries. This is believed to be the first agreement of its kind between a British and an American company. The arrangement is based on the experience of the Mitchell company in civil-engineering works and thermal power stations and on the knowledge of reactor and reactor-component design provided by A.M.F. Atomics. A closed-cycle boiling-water reactor of approximately 60 MW output (Fig. 1) has been chosen, which can operate on natural-uranium fuel, and is thought to offer particular scope for use in South Africa where the ore is readily available and where the problem of hauling coal and oil over long distances is at present formidable. The estimated capital cost of such a station, most of which would be situated below ground level, is £100 per installed kilowatt. The Mitchell company's headquarters are at 1 Bedford-square, London, W.C.1.

The second announcement of this kind concerns the A.E.I.-John Thompson Nuclear Energy Company, Limited, which was incorporated on February 22, with an authorised capital of £1 million. The issued capital is held in equal quantities by the British Thomson-Houston Company, Limited, the Metropolitan-Vickers Electrical Company, Limited, and John Thompson Limited. The new company replaces and absorbs the A.E.I.-John Thompson Nuclear Energy Group and has as its main objects the development, design and supply of nuclear reactors of all types. It will also act as main contractors for the construction of nuclear power stations. The company is at present engaged in building a research reactor, known as Merlin, at the A.E.I. Research Establishment at Aldermaston. This reactor together with various items of equipment made by the company's constituent firms, will be described in later sections of this article. Apart from those already mentioned, other firms represented in the new organisation, which has its head office at Oak House, Cross-street, Sale, Cheshire, and its registered office at Crown House, Aldwych, London, W.C.2, are Sunvic Controls Limited and Isotope Developments Limited.

Within a few days of the preceding announcements the decision to form another company group for atomic-energy development was made public—this time with the initial object of applying nuclear power to marine propulsion. The company established for this purpose, and generally to control Vickers group policy on engineering development in the atomic field, is known as Vickers Nuclear Engineering Limited, and will provide for co-operation between Vickers Limited, Rolls-Royce Limited, and Foster Wheeler Limited. Rolls-Royce whose plans are discussed in the following paragraph, have previously declared their interest in nuclear engineering, while Foster Wheeler have already some years' experience of atomic-energy development work. These firms can act independently or together as a group. The announcement was made on February 23 by Vickers Limited, (whose headquarters are at Vickers House, Broadway, London, S.W.1).

REACTORS IN THE AIR

Rolls-Royce work on the application of atomic energy to aircraft propulsion and related fields, which has been in progress for the last 18 months, will shortly be augmented by the completion of a nuclear engineering laboratory specially designed and built for the purpose. The company are applying their engineering experience to the development of light-weight reactors for ultimate use with engines suited to air and surface transport. The nuclear research and development team has been built up from the company's Aero Engine Division Advanced Planning Group associated with Dr. A. A. Griffith, F.R.S., and supplemented by specialists from outside including, Dr. S. G. Bauer and Mr. C. D. Boodle from the Atomic Energy Research Establishment, Harwell. The first experimental high-temperature work on liquid metals began last July in temporary test facilities in the main Rolls-Royce works at Derby. Valuable results have already been obtained.

Most recent of these developments is the announcement this week by Richardsons, Westgarth and Company, Limited, of the formation of a separate company to take over the group's studies and developments in the atomic field. Known as Richardsons Westgarth Atomic Limited, the new subsidiary will have its registered office at 56 Victoria-street, London, S.W.1. (See section on propulsion.)

Reactors.—Probably the two most interesting nuclear-reactor developments during the last two months are in connection with the A.E.I.-John Thompson "swimming-pool" research reactor Merlin, details of which have now been published, and a number of American experimental reactors using liquid fuels including molten plutonium. Merlin is shown in Fig. 2.

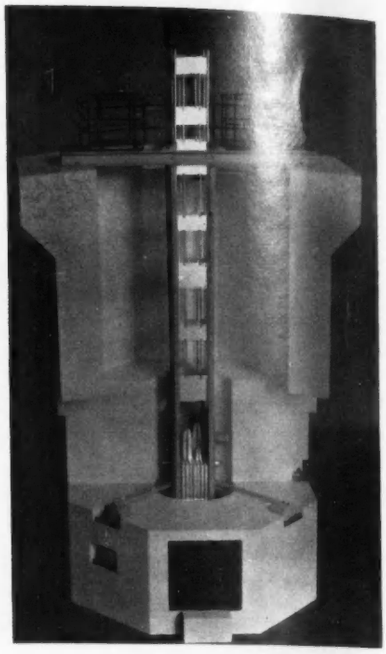
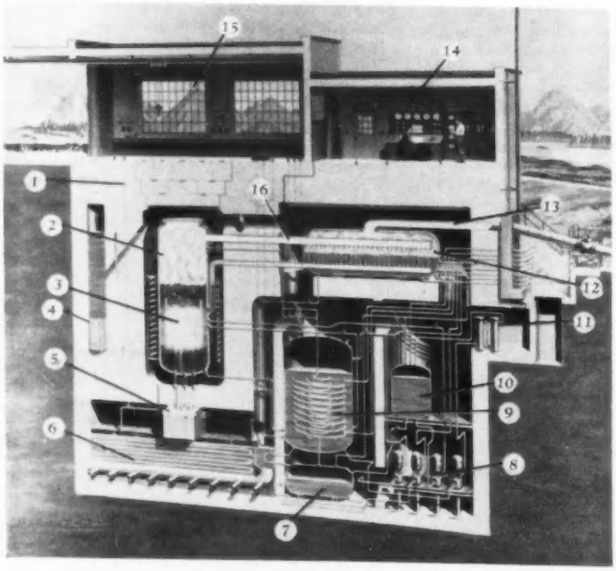


Fig. 2 Model of A.E.I. training reactor Merlin under construction at Aldermaston. It will be cooled and moderated by light water.



1. Concrete containment. Stainless-steel linings.
2. Reactor vessel.
3. Uranium fuel rods.
4. Fuel-rod storage tank.
5. Reactor controlling mechanism.
6. Containment quench tank.
7. Sump tank.
8. Pumping units.
9. Blow-down vessel.
10. Demineralised feed-water tank.
11. Demineralisers.
12. Heat exchangers.
13. Secondary steam pipe to turbo-alternator.
14. Control room.
15. Fuel handling room.
16. Primary steam loop.

Fig. 1 Mitchell Engineering Ltd. and A.M.F. Atomics Inc. are to co-operate in offering complete nuclear power plants for sale. Boiling-water reactors, as shown, of some 60 MW are expected to form the basis of these projects.

MERLIN RESEARCH REACTOR

The A.E.I.-John Thompson reactor Merlin (Medium Energy Research Light-Water Moderated Industrial Nuclear Reactor), which is to serve as an engineering prototype for research and training, is intended to be critical in 1957 and will employ an enriched uranium-oxide fuel containing 20 per cent. uranium 235 of which there will be some 4·5 kgm.—hot, poisoned and with experimental absorbers. The fuel lattice will consist of 12 plates in a box about 3 in. by 3 in. by 24 in. and the fuel will be clad in aluminium 0·02 in. thick. Both moderator and coolant will be ordinary water and the reflector will have a minimum of 4 in. of water at top and bottom with beryllia or graphite 3 in. or 6 in. thick at the sides; the tank will be of aluminium. The shield will comprise 13 in. of water and barytes concrete 6 ft. 3 in. thick, with at least 18 ft. 6 in. of water on top. The core will occupy a volume of 2 ft. 3 in. by 2 ft. 3 in. by 2 ft. and the overall dimensions will be 28 ft. high by 16 ft. 6 in. across flats. The reactor building, which has been designed by Atkins and Partners, Limited, is 60 ft. in diameter and 47 ft. 3 in. high.

Under operating conditions the normal thermal power will be 1 MW, with a 5 MW maximum, and the estimated fuel consumption per day of operation at 1 MW will be 1 gm. of uranium 235.

The coolant velocity in the core is expected to be 2·5 ft. per second at 5 MW, requiring a pumping rate of 1,600 gals. per minute and a pumping power of 120 h.p. The cooling system is to employ recirculating water, which will pass through a filter and demineralisation plant. In an emergency, safety will be ensured by natural convection or boiling.

The control rods will consist of cadmium sheet in aluminium containers, giving reactivity control of 0·5 per cent. for fine adjustment and 8 per cent. for coarse, with twice this value available for safety purposes. Fuel will be charged and discharged by remote handling devices, and used elements will be stored in the shield. Some further details of the reactor are listed in the table below.

Operating Data for Merlin

Temperatures:	
Coolant inlet	35 deg. C.
Coolant outlet	45 deg. C.
Fuel (max.)	92 deg. C.
Sheath (max.)	90 deg. C.
Physics (preliminary calculations, cold, unpoisoned):	
Resonance escape	0·96
Thermal utilisation	0·75
Diffusion length	1·65 cm.
Slowing-down length	7·36 cm.
Laplacian	0·0085 cm.$^{-2}$
k_∞	1·50
Radiation fluxes (at 5MW):	
Epithermal neutrons (max.)	2×10^{13} n per cm.^{2} per sec.
Thermal neutrons (max.)	5×10^{13} n. per cm.^{2} per sec.
Gamma radiation (edge of core)	2×10^6 rad. per hr.

The experimental facilities of the reactor will be arranged in two core positions. In the first there will be two graphite thermal columns, 4 ft. 6 in. square and 7 ft. 4 in. long; one 12 in. diameter beam hole; three 6 in. diameter beam holes; and a central hole in the core, 3 in. by 3 in. In the second position there will be two 6 in. diameter through tubes; four 6 in. diameter beam tubes; two 8 in. diameter vertical tubes; a central hole, 3 in. by 3 in.; and a shelf adjacent to the core to take a 2 ft. cube.

Fuel for the reactor, on which work has already begun, at the A.E.I. Research Establishment, Aldermaston Court, will be provided by the United Kingdom Atomic Energy Authority. The reactor will be available not only to the company and its associates but also for the instruction of students from universities, technical colleges and research institutions. Research at Aldermaston, where there is also a 4 million volt particle accelerator, is under the direction of Dr. T. E. Allibone, F.R.S.

MOLTEN PLUTONIUM FUEL

If the nuclear reactor of the future is to be economic and convenient to run it must provide simple means of continuously processing the fuel and fission products. This problem is receiving considerable attention in the United Kingdom, where research is being carried out with the aid of the homogeneous reactor ZETR (Zero Energy Tank Reactor) using as fuel a solution of highly enriched uranyl sulphate (Fig. 3); and in the U.S.A., where a number of liquid-slurry uranyl phosphate in water and uranium-bismuth, for example) and molten-metal fuelled systems are under investigation. In the homogeneous reactor, fuel and moderator are mixed in a single "homogeneous" fluid, and it has been reported that two experimental models are at present under construction at Los Alamos —LAPRE (Los Alamos Power Reactor Experiment) No. 1 and LAPRE No. 2. Both are aqueous homogeneous power reactors with solutions of enriched uranium, phosphoric acid and water as fuel. This necessitates the use of a gold-lined stainless steel vessel to contain the core and also the heat exchanger. Probably the most important feature of such a system would be the possibility of producing high-temperature superheated steam, thus permitting the use of modern turbines; LAPRE 1 is expected to be the first reactor capable of achieving this. LAPRE 1 is to have a heat output of about 2 MW and LAPRE 2, which will have no moving parts and should be specially suitable for "package power" applications, will be rated at 1·3 MW. Both reactors should be completed within the present year.

Los Alamos is also experimenting with molten-metal fueled reactors and a pilot model LAMPRE—(Los Alamos Molten Plutonium Reactor Experiment) with a heat rating of approximately 1 MW is in hand. It will operate at some 1,400 deg. F. and could be used for breeding. In addition, a 100 MW version is envisaged. Another suggestion aimed at the fuel-processing problem was made at a recent nuclear-energy conference in Cleveland. The proposed reactor scheme has the somewhat contradictory designation, "continuously processed heterogeneous reactor," and employs as fuel exposed uranium, which corrodes in the coolant liquid. The rate of corrosion is arranged to coincide with the rate at which fission products form; these dissolve together with uranium and are continuously removed from the coolant, while the fuel is replenished by dropping additional pieces of uranium into the fuel bed.

FRENCH G1 STARTED UP

Miscelleneous news in the reactor field includes the starting up of the French combined power reactor and plutonium producer G1 on January 7. With a heat capacity of 40 MW but an electrical output of only 5 MW, the reactor is graphite moderated and air cooled, and powers what is probably the second central power station employing atomic energy to come into operation; the Russian 5 MW station described at the Geneva Conference last year was the first. Current interest in the gas-cooled reactor used in combination with a closed-cycle gas-turbine circuit is illustrated by a proposal that such a system be included in part two of the United States Atomic Energy Commission's power-reactor programme. The total number of private plants under construction, designed or proposed in the United States, is now 16. The training of engineers and scientists for this programme will be aided by the use of practical facilities and the Massachusetts Institute of Technology have recently announced that work will shortly begin on the building of their heavy-water cooled 1 MW training reactor, which will employ an alloy of uranium 235 and aluminium as fuel.

Mr. D. G. Zhimerin, a member of the Soviet delegation of electrical engineers who recently visited this country, stated that the Soviet Union planned to have 2·5 million kW installed atomic power station capacity, and the reactors to be used would be of pressurised-water, heavy-water and gas-cooled design (see Weekly Survey).

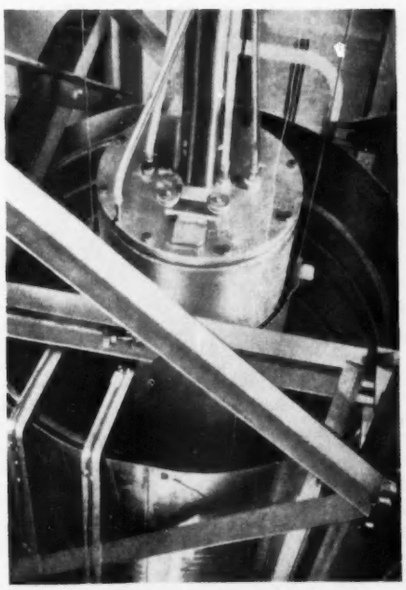


Fig. 3 ZETR (Zero Energy Test Reactor) at Harwell. It is a homogeneous reactor using a solution of uranyl sulphate in water.

In Britain, there is a possibility that apart from the plants scheduled for Dounreay and Annan, a further Scottish atomic-power project may be undertaken in the Moray Firth area, but it has been suggested that the majority of stations are likely to be in the south, mainly, on the Essex coast and in the Severn estuary. It is also of interest that within recent months both Lord Citrine and Sir Christopher Hinton have confirmed that the early nuclear power stations will probably produce electricity at a gross cost higher than the current cost of base-load stations, but that future reactor developments may well reverse the position.

PLUTONIUM PILES

Of a speculative nature is the prospect that it may soon be possible to use plutonium produced at Windscale, and later by the atomic power stations such as Calder Hall, as a reactor fuel. Recent statements that these power stations would not be competitive with present coal-fired base-load stations suggest that the sale value of plutonium has fallen since last August; this may mean that with diminished international tension there has been a reduction in the military demand for plutonium, and that stocks will become available for power production. This view is perhaps supported by the decision of the Americans to build a molten-plutonium reactor.

Propulsion.—At present, reactors for propulsion offer mixed prospects. Sir John Cockcroft has recently confirmed that the nuclear reactor has some way to go before it can be used to drive locomotives competitive with Diesel locomotives, since the weight of shielding required would be prohibitive, but it has been reported that plans for nuclear-driven locomotives are being considered in Western Germany, and in the U.S.A. These, however, would almost certainly be used for display or experimental purposes and could not be regarded as prototypes for normal railway service. In military aircraft, where economic operation is not a major factor, some progress has been made, in that a test reactor for investigating shielding, radiation effects and nuclear instrumentation has been installed in a B-36 machine. The success of the United States submarine Nautilus has led the American naval authorities to emphasise their intention of building nuclear powered surface craft, and seven different reactor schemes are at present under consideration for this purpose. The Royal Navy is also planning to commission reactor-driven submarines and will not buy them ready made from the United States. It is significant that, as stated above, Richardsons, Westgarth and Company, a firm concerned with the building of marine propulsion machinery, has formed a subsidiary for the atomic-energy development; and that the American locomotive firm Alco should have undertaken the building of the U.S. Army Package Power Reactor.

POWER REACTOR POSTSCRIPT

An American newspaper reports that according to Mr. L. R. Hafstad, until last year United States Atomic Energy Commission director of reactor development, Britain has taken over world leadership in the peacetime application of atomic power. This, he said had arisen from the incentive provided by the high cost of competing fuels in the United Kingdom. He was appealing to the U.S. Government for relaxed security rules and the subsidising of private companies entering the nuclear field.

(In a subsequent article we hope to deal with techniques and products developed by private companies during the last two months together with developments of a national and international nature. In this first article several items of information were extracted from the *Atomic Scientists' Journal* and the official American publication *Atoms for Peace Digest*.)

In Parliament

TECHNOLOGY ON TEES-SIDE

Among the series of adjournment debates which preceded the Easter recess was one in the House of Commons on the need for the special development of technical education on Tees-side. This subject was raised by Mr. H. A. Marquand (Labour), who expressed his regret at the omission of any reference to Tees-side in the Government's White Paper on *Technical Education* (Cmd. 9703). He felt that the practice of referring to the North-East Coast and of assuming that if something be done for Newcastle-upon-Tyne, or Sunderland, or some other town in that area, the benefit applied to the whole region, was a wrong one.

Three great rivers ran into the North Sea in that district, the Tyne, the Wear and the Tees, and each of them had its own distinct industrial area. The fact that something was done, for example, at Newcastle-upon-Tyne, where there was a famous college of engineering, or at Sunderland, which already possessed an efficient technical College, did not necessarily mean that the needs of Tees-side were satisfied. Tees-side was the latest of the three areas to develop industrially and, for that very reason, it was now expanding the most rapidly of them all. Actually, it was probably the most rapidly expanding industrial area in the whole of Great Britain.

The area contained the largest centre of the chemical industry in this country. Billingham had been developed by Imperial Chemical Industries Limited, principally during the days of depression, and that firm had now started, and was rapidly enlarging, another immense establishment at Wilton. Tees-side was probably chiefly famous for its steel industry. Both Dorman, Long and Company Limited, and the South Durham Steel and Iron Company Limited, had expanded and modernised their works in recent years. Structural engineering and general engineering were also well established. The famous firms of Head, Wrightson and Company, Limited, and the Tees Side Bridge and Engineering Works, Limited, might be cited as examples.

Claims of Constantine College

Even at the present level of development, the technical requirements of the area were not being met. As with the acute need for technicians throughout the country, the only solution lay in training more people. The Government envisaged a five-year extension plan for technical education which aimed at increasing the supply of technologists by 50 per cent., principally through the work of 24 colleges, and it seemed an unreal proportion that eleven of these were located in the London district and only four in the North of England. Where "developments now in train or the movement of industry" justified it, a few other colleges might qualify for the Government's 75 per cent. grants. Middlesbrough, which stood at the focal point of Tees-side, had in Constantine College an institute that surely possessed almost all the requirements that had been deemed sufficient in the other colleges. It should qualify for one of these grants. There were 4,700 students, excluding the art department, now at the college. Between 1945 and 1953, there were 75 students who gained external degrees, including 36 in engineering. Of the 1,522 students in England and Wales engaged on sandwich courses, 11 per cent. were at Constantine College.

Mr. Dennis Vosper, Parliamentary Secretary to the Ministry of Education, observed in reply, that the White Paper mentioned for the first time colleges of advanced technology; these being colleges which *concentrated* on courses of that type. The application of Constantine College was based on courses in science, not mechanical engineering, and was unsuccessful because the volume of advanced work did not measure up to requirements for the higher grant.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Problems Encountered in Overseas Installations," by J. Flood. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Tues., April 17, 6.30 p.m.

Austrian Institute

LONDON
"The Influence of Structural Ordering on the Properties of Metallic Materials," by Professor E. Schmid. Fri., April 20, 6.30 p.m.

Birmingham Exchange and Engineering Centre

BIRMINGHAM
"Test Flying," by A. J. Pegg. Thurs., April 19, 6.30 p.m. (Admission by ticket.)

British Institution of Radio Engineers

LONDON
"Radio and Television Interference: Its Growth and Effects," by M. Smith. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., April 25, 6.30 p.m.*

British Interplanetary Society

LONDON
Annual General Meeting. (Members only.) Caxton Hall, Victoria-street, S.W.1. Sat., April 21, 6 p.m.

Building Centre

LONDON
Films on "Power Tools in the Building Industry." Wed., April 18, 12.45 p.m.

Chadwick Public Lecture

LONDON
"The Centenary of London's Main Drainage System," by J. Rawlinson. Royal Society of Health, 90 Buckingham Palace-road, London, S.W.1. Thurs., April 26, 5.30 p.m.

Chemical Society

BELFAST
"Adsorption by Porous Solids," by Professor D. H. Everett. Northern Ireland Branch. Queen's University, Belfast. Thurs., April 19, 7.45 p.m.
BRISTOL
"Magnetism and the Shape of Inorganic Molecules," by Professor R. S. Nyholm. Bristol Branch. Chemical Department, The University, Bristol. Thurs., April 26, 5.15 p.m.
MANCHESTER
Symposium on "Lubrication." Manchester Branch. The University, Manchester. Thurs., April 19, 10.30 a.m. and 2.30 p.m.
ST. ANDREWS
"New Kinds of Macromolecules," by Professor H. W. Melville. St. Andrews and Dundee Branch. Chemistry Department, St. Salvators College, St. Andrews. Fri., April 20, 5.15 p.m.

Illuminating Engineering Society

BIRMINGHAM
"Blackpool Illuminations," by H. Carpenter. Birmingham Centre. Regent House, St. Phillip's-place, Colmore-row, Birmingham. Fri., April 27, 6 p.m.
BRISTOL
Annual General Meeting and Film Evening. Bath and Bristol Centre. Royal Hotel, Bristol. Fri., April 20, 7 p.m.
LEICESTER
Film Evening. Leicester Centre. Offices of the East Midlands Electricity Board, Charles-street, Leicester. Mon., April 23, 6 p.m.
LIVERPOOL
Open Discussion Meeting. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., April 17, 6 p.m.

Incorporated Plant Engineers

LONDON
"Some Aspects of District Heating Schemes," by W. A. Gregory-Carter. London Branch. College of Preceptors, Bloomsbury-square, W.C.1. Thurs., April 19, 7 p.m.*
BLACKBURN
"Electronics in Industry," by A. Worland. Blackburn Branch. Golden Lion Hotel, Blackburn. Thurs., April 19, 7.30 p.m.
NOTTINGHAM
"A Personal Approach to the Design of Control Gear," by J. B. Saunders. East Midlands Branch. County Hotel, Theatre-square, Nottingham. Wed., April 18, 7 p.m.
ROCHESTER
"Modern Workshop Techniques," by A. Barnes. Kent Branch. Bull Hotel, Rochester. Wed., April 18, 7 p.m.

Institute of British Foundrymen

LONDON
Annual General Meeting. "Casting of a Large Winding-Drum Cheek," by A. W. Bartlett. London Branch. Waldorf Hotel, Aldwych, W.C.2. Wed., April 25, 7 p.m.
BIRMINGHAM
Annual General Meeting. Birmingham Branch. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., April 25, 7.15 p.m.
COVENTRY
Annual General Meeting and Film Evening. Coventry Section. Technical College, Coventry. Tues., April 24, 7.30 p.m.

Institute of Fuel

LONDON
Annual Corporate Meeting. Institution of Civil Engineers, Great George-street, S.W.1. Wed., April 18, 5.30 p.m.*

Institute of Industrial Supervisors

LONDON
"Job Evaluation," by L. E. Glover. London South-East Section. Woolwich Polytechnic, S.E.18. Thurs., April 19, 7.30 p.m.

Institute of Marine Engineers

LONDON
"Fundamental Principles of Marine Instrumentation," by F. P. Rout. Mon., April 23, 6.30 p.m.*
Annual General Meeting. Tues., April 24, 5.30 p.m.*
LIVERPOOL
"The Carriage of Edible Oil and Similar Bulk Cargoes," by John Wormald. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Mon., April 23, 6.30 p.m.*

Institute of Metals

LONDON
"The Beginnings of Metallography," by Professor Cyril S. Smith. Wed., April 25, 6.45 p.m.

Institute of Refrigeration

LONDON
"The Use of Radioactive Techniques in Refrigeration Engineering," by D. B. Smith. Institution of Mechanical Engineers, 1 Birdcage-walk, S.W.1. Thurs., April 26, 5.30 p.m.*

Institute of Welding

LIVERPOOL
Annual General Meeting and Film Evening. Liverpool Branch. Liverpool College of Technology, Byrom-street, Liverpool. Tues., April 17, 7.15 p.m.

Institution of British Agricultural Engineers

LONDON
"Hydrostatic Transmission for Tractors," by H. J. Hamblin. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., April 24, 6 p.m.*

Institution of Chemical Engineers

LONDON
Annual General Meeting. Business Session, for corporate members only, at 11 a.m. Presidential Address on "The Technological Awakening," by John A. Oriel, at 12 noon. Annual Dinner at 7 for 7.30 p.m. May Fair Hotel, Berkeley-street, W.1. Tues., April 24.

Institution of Civil Engineers

LONDON
"Glen Shira Hydro-Electric Project," by John Paton. Tues., April 17, 5.30 p.m.*
"The Investigations, Design and Construction of Paya Lebar Airport, Singapore," by J. J. Bryan. Airport Division. Tues., April 24, 5.30 p.m.*
SHEFFIELD
Annual General Meeting. Yorkshire Association. Royal Victoria Hotel, Sheffield. Fri., April 27, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "Inspection and Maintenance of Wood Poles," opened by K. L. May. Mon., April 16, 5.30 p.m.*
"The Indirectly-Heated Thermistor as a Precise A.C./D.C. Transfer Device," by F. C. Widdis; and "A Bridge for the Measurement of Permittivity," by A. M. Thompson. Measurement and Control Section. Tues., April 17, 5.30 p.m.*
Address by the President of the Institution, Sir George H.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Austrian Institute, 28 Rutland-gate, South Kensington, London, S.W.7. (KNIghtsbridge 5556.)
Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham 2. (Midland 1914.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1.
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chadwick Trust, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham 4. (Midland 6971.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. (SLOane 6233.)
Institute of Refrigeration, New Bridge Street House, New Bridge-street, London, E.C.4. (CENtral 4694.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of British Agricultural Engineers, 6 Buckingham-gate, London, S.W.1.
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (Langham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Railway Signal Engineers, Euston House, Eversholt-street, London, N.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Water Engineers, Parliament Mansions, Abbey Orchard-street, London, S.W.1. (ABBey 6740.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Royal Aeronautical Society, 4 Hamilton Place, London, W.1. (GROsvenor 3515.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0[illegible].)
Royal Microscopical Society, Tavistock House South, Tavistock-square, London, W.C.1. (EUSton 204[illegible])
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)

Nelson, F. London Graduates' and Students' Section. Wed., April 18, 6.30 p.m.*
"Temperature Rises in Electrical Machines as Related to the Properties of Thermal Networks," by Dr. J. J. Bates and Professor A. Tustin; "Temperature Rises in Electrical Machines with Variable Load and with Variable Speed," by Professor A. Tustin and Dr. J. J. Bates; and "Performance and Heating Curves for Motors on Short-Run Duties," by Professor A. Tustin, D. F. Nettell and R. Solt. Utilization Section. Thurs., April 19, 5.30 p.m.*
Discussion on "Theories of Electromagnetic Induction," to be opened by Professor G. W. Carter. Education Discussion Circle. Fri., April 20, 6 p.m.*
EDINBURGH
"The Recent Search for and Salvage of the Comet Aircraft near Elba," by Commander C. G. Forsberg and G. G. MacNeice. South East Scotland Sub-Centre. Carlton Hotel, North Bridge, Edinburgh. Tues., April 17, 7 p.m.

Institution of Heating and Ventilating Engineers

LONDON
Annual General Meeting and Presidential Address. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., April 18, 6 p.m.*
GLASGOW
Annual General Meeting and Discussion on "Heating of Large Chambers." Scottish Branch. Scottish Building Centre, 475 Sauchiehall-street, Glasgow, C.2. Tues., April 24, 7 p.m.
LIVERPOOL
Annual General Meeting. Liverpool Branch. College of Building, Clarence-street, Liverpool. Wed., April 25, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Front Suspension and Tyre Wear," by V. E. Gough. Automobile Division. Tues., April 17, 5.30 p.m.*
Discussion sponsored by the Hydraulics Group. Thurs., April 19, 6.45 p.m.*
"Experimental Courses in Graduate Training," by D. L. Marples, J. F. A. Radford and J. L. Reddaway. Fri., April 20, 5.30 p.m.*
Discussion on "Are Diesel Engines Inherently Noisy?" Internal Combustion Engine Group. Tues., April 24, 6.45 p.m.*
BIRMINGHAM
"Hydraulics as Applied to Reciprocating Machine Tools," by George Butler. Midland Branch. James Watt Memorial Institute, Great Charles-street, Birmingham. Thurs., April 19, 6 p.m.
RUGBY
"A Criticism of the Technical Education of Recently Qualified Engineers," by P. P. Love. Midland Branch. College of Technology and Arts, Eastland, Rugby. Tues., April 17, 6.30 p.m.

Institution of Mining and Metallurgy

LONDON
"Copper and Silver in Silicate Slags," by Dr. F. D. Richardson and J. C. Billington; and "Underground Mining in the Frodingham Ironstone," by A. Alec Jones. Geological Society, Burlington House, Piccadilly, W.1. Thurs., April 19, 5 p.m.*

Institution of Production Engineers

LONDON
"Radioactive Materials in Industry," by Dr. A. D. Merriman. South Eastern Region. Royal Empire Society, Craven-street, Strand, W.C.2. Thurs., April 19, 7 p.m.
"The Finishing of Work by Polishing or Plating," by H. Cann. London Graduate Section. Tues., April 24, 7.15 p.m.
ILFORD
"Production Methods in the Furniture Industry," by E. F. Powell. South Essex Section. Ilford Club, 21A Balfour-road, Ilford. Wed., April 18, 7.30 p.m.

Institution of Railway Signal Engineers

LONDON
Annual General Meeting. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Wed., April 18, 6 p.m.*
BRISTOL
"The Signal Engineer and the Footplate," by S. Williams. Staff Canteen, Approach-road, Temple Meads Station, Bristol. Tues., April 17, 6 p.m.*

Institution of Structural Engineers

LONDON
"Design and Construction of the Printing Works at Debden," by Sir Howard Robertson, Ove Arup, R. S. Jenkins and H. F. Rosevear. Thurs., April 26, 6 p.m.

Institution of Water Engineers

LONDON
Annual General Meeting. "Water Treatment in the Tropics," by E. Field Reid. South Eastern Section. Institution of Civil Engineers, Great George-street, S.W.1. Thurs., April 19, 2.30 p.m.

Junior Institution of Engineers

LONDON
"Sensitive Instruments Used by Faraday and Unchanged in Present Everyday Use," by H. J. N. Riddle. Fri., April 20, 7 p.m.*

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Geared-Diesel Marine Machinery with Particular Reference to the Performance of Two Installations of Different Types," by J. Calderwood. Mining Institute, Newcastle-upon-Tyne. Fri., April 20, 6.15 p.m.

Royal Aeronautical Society

LONDON
"Investigation of Aircraft Accidents," by E. L. Ripley. Tues., April 17, 5 p.m.
"High-Speed Experimental Test Flying," by Lieut.-Colonel Charles E. Yeager. Institution of Civil Engineers, Great George-street, S.W.1. Thurs., April 19, 6 p.m.*

Royal Meteorological Society

LONDON
Annual General Meeting. Presidential Address on "The Moisture Balance of the Atmosphere," by Dr. R. C. Sutcliffe. Wed., April 18, 5 p.m.*

Royal Microscopical Society

LONDON
"Simple Micromanipulators," by Dr. R. J. Goldacre. Wed., April 18, 7.30 p.m.

Royal Society of Arts

LONDON
"Modern Welding," by Dr. H. G. Taylor. Mon., April 16, 6 p.m.
"T. H. Huxley and Technical Education," by Dr. Cyril Bibby. Wed., April 18, 2.30 p.m.

750 kW GERMANIUM RECTIFIER FOR MAIN-LINE TRACTION

INTERESTING DEVELOPMENT ON BRITISH RAILWAYS

At the end of 1951, the British Transport Commission decided to carry out trials on the Lancaster-Morecambe-Heysham line in the London Midland Region with the single-phase system of electric traction at 50 cycles, using voltages from 6·6 kV to 20 kV. For this purpose three existing direct-current units, consisting of a motor-coach, trailer coach and driving trailer coach, were equipped with transformers and two rectifiers of English Electric manufacture. These rectifiers, which were of the sealed steel-tank mercury-arc type with six anodes paralleled in groups of three, each supplied two traction motors; these motors were connected in series with the mid-point earthed, through smoothing reactors.

Trial runs were begun late in 1952, and a regular passenger service was operated until 1955, when it was temporarily suspended in order that certain reconstruction work to the overhead equipment could be carried out. In the autumn of that year, too, the mercury rectifiers on one of the train sets were replaced by a 750 kW germanium rectifier, supplied by the British Thomson-Houston Company Limited, Rugby, the conversion being carried out in the L.M.R.'s workshop at Meols Cop, near Southport.

At the beginning of March tests were made with this train from Fenchurch Street to Bow Junction, a section which has already been equipped with overhead contact wires pending the electrification of the line from London to Tilbury. These trials have been made at night with single-phase alternating current at 6·6 kV, 50 cycles to investigate any interference with the signalling and communication circuits.

The germanium rectifier, which is the first of its kind to be used for traction purposes, is illustrated in Fig. 1 and, as will be seen, consists of an enclosed angle-iron framework carrying vertical trays on which the units proper are mounted. These trays are supported on runners, which can be easily withdrawn for inspection and maintenance; and the units are cooled by an extractor fan on the top of the cabinet in which they are enclosed. The manufacture of each unit, the arrangement of which is shown diagrammatically in Fig. 2, requires elaborate precautions in order to avoid contamination and it is finally enclosed in an hermetically sealed case to exclude moisture. Each unit illustrated is rated at about 1 kW and will carry a mean current of 50 amperes. Its performance characteristic is given in Fig. 3.

The necessary speed regulation of the motors is obtained by varying the voltage of the alternating current input to the rectifier by altering the position of the tapping switch on the transformer. As regards performance when the direct-current voltage required from the rectifier is higher than can be obtained from a simple three-phase bridge, the units must be connected in series. Owing, however, to the variation in the characteristics of the individual units the reverse voltage will not be evenly divided between them. For currents greater than three times the rating, units or strings of units must be connected in parallel and the current in the parallel paths reduced so that no unit is overloaded.

The power loss occurring during the reverse part of the rectifying cycle is so small compared with the forward loss (which is in itself small) that it can be neglected. The forward voltage drop at full load is about 0·5 volts or 1 volt when the current flows through two units in series. If the peak inverse voltage across a unit is limited to 70 volts the loss is 1·5 per cent. to which a further 0·2 per cent. must be added for losses in connections, cooling fan and fuses, making a total of 1·7 per cent. The losses in the main transformer for a 1,000 kW equipment would be about 1·3 per cent. so that the overall efficiency is 97 per cent.

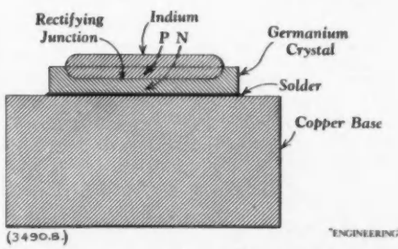


Fig. 2 Typical rectifying junction.

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POST-FORMED FORMICA

A new grade of Formica laminated plastics sheeting, which can be post-formed in single curvature to a radius of 1 in. after heating to 325 deg. F. in an infra-red heater, has been introduced by Thomas De La Rue and Company Limited (Plastics Division). The laminate has the same characteristics of toughness, durability, wear and chemical resistance as the standard grade, but is slightly more heat resistant.

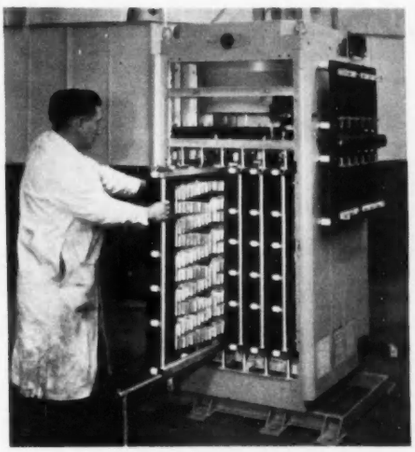

Fig. 1 A 750 kW germanium traction rectifier with one of the banks withdrawn for examination.

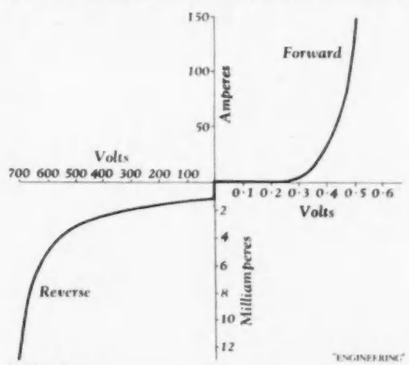

Fig. 3 Performance characteristic of germanium rectifier at 20 deg. C., showing the high forward and low reverse currents that pass for given input voltages.

THE HUMAN ELEMENT

T.U.C. secretary advises Kenya Government and union—Engineering employers' offer being considered by unions—Hint on national wages policy from union leader—Work study can be over-employed—End of a very long strike—Arts students transferring to science.

★ ★ ★

Growing Pains in Kenya

Some remarkable candidates for official registration as trade unions have come before the authorities in various British colonies in the last decade or two. On the whole the registrars have steered a sound course between ensuring the minimum standards of conduct by union officials in communities where corruption was until recently an accepted institution, and of not smothering trade union consciousness. Recently in Kenya the system nearly came to grief.

The Kenya Federation of Labour has had a good record during the years of Mau Mau but it has occasionally indulged in frankly political propaganda at a time when the Government had to be exceedingly strict about the kind of African organisations which could be tolerated. The Kenya registrar threatened to cancel the federation's registration, which would have made it an illegal body. It was a situation beyond the scope of any registrar, for whatever may have been the formal issue the federation stands for nascent and decent trade union organisation among Kenya Africans in an area where law and order have been challenged.

In the event, the general secretary of the Trades Union Congress flew out to Kenya to make available the offices of the T.U.C. These offices have been useful in bringing about a removal of the crisis. The Government has accepted the principle of prior consultation on decisions likely to affect labour organisations and the officers of the Federation have agreed not to undertake political activities in the name of or with the authority of the Federation. A useful gain has been achieved for the evolution of responsible trade unionism in a country which at the moment could only too easily foster on the one hand political irresponsibility or sedition or on the other blind and fearful suppression.

★ ★ ★

Improved Pay for Night Work

An offer to raise the premium for night work in engineering from time-and-a-fifth to time-and-a third, and the night-shift overtime rate from time-and-a-third to time-and-a-half for the first two hours, has been made by the Engineering and Allied Employers' National Federation. This is the outcome of negotiations between the employers and leaders of the Confederation of Shipbuilding and Engineering Unions, and the only concession made by the employers to a long list of demands for improved conditions put forward by the unions.

Among rejected demands were increased pay for skilled maintenance men, double-time for all overtime on week-days and treble-time on Sundays, payment for work lost through sickness, a pension scheme for manual workers and other claims which, if granted, would have cost the industry £120 million a year. The employers promised to consider a claim for increased pay for apprentices, boys and youths. The cost of the concession on night work is estimated at £5 million a year to federated firms and at £10 million a year to the engineering industry as a whole.

The employers' reply will be considered by the Confederation at a meeting being held this week in York. There is little doubt that a hard struggle is in prospect, since the unions are unlikely to abandon easily claims for which there was strong rank-and-file support at the annual conference. A most important request was for dealing with questions of redundancy at district level. The employers prefer the existing procedure of negotiations between management and shop stewards at company level, but have agreed to consider the matter further. This would go some way towards the wish expressed by motor-industry shop stewards earlier this year for industry-wide negotiations.

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No Wage Restraint for Retail Shop Workers

A near-unanimous vote in favour of further wage claims this year, passed at the Easter conference of the Union of Shop, Distributive and Allied Workers is a clear warning to the Chancellor of the Exchequer that his appeal for voluntary restraint is unlikely to succeed. Managements, too, show little inclination to restrict the distribution of profits unless they are required for expansion The U.S.D.A.W'S general secretary, Mr. Alan Birch, suggested that the unions could hardly be expected to restrain their members' demands for higher wages until the Government had successfully stabilised prices. And since it is hardly in the Government's power to do so merely by impassioned appeals, a tough Budget must be expected.

Mr. Birch expressed dissatisfaction with the trade union's role of chasing prices and suggested that " in conditions of full employment, responsibility lies with the trade union movement as a whole to adopt a more co-ordinated policy over the whole field of wages in the true spirit of solidarity which is the essence of trade unionism, rather than conduct a sectional scramble for individual advancement." That a suggestion of a national wages policy should come from a trade union leader who is a member of the T.U.C. General Council and of the Monopolies Commission is, to say the least, surprising. It will find ready ears, particularly among craft unions who want recognition of their skills in cash, but immediate progress is unlikely.

The T.U.C. may deal with Mr. Birch's suggestion in their forthcoming economic survey. The need for a wages policy is evident enough; the likelihood of effective central leadership on wages is unfortunately rather remote. How many union leaders are now in a position to carry their rank and file with them when preaching moderation? The answer suggests that Mr. Birch's plea for a co-ordinated policy over wages is likely to remain a plea.

★ ★ ★

Work Study

The protaganists of more and better work study have advocated the need for its correct use, and work study has now an honoured place among industrial techniques. It is indeed an essential and long-overdue amalgam of common sense, the technique of thinking out all processes from first principles and accepting nothing at face value, the assessment of alternative techniques for doing a job and the proper use of time and motion study.

But it is in some danger of going too far too quickly. It can be misapplied. It is a method of dealing with industrial problems under comparatively stable conditions. Observe that those companies which of recent years have done most useful work for themselves and as an example to others have been large organisations which can look forward to long periods of stability for one reason or another. Work study is a tricky technique to use at times of great expansion or acute competition in the market for one's product.

It can also run into difficulty owing to lack of skilled personnel to practice it properly. Two of the nationalised industries are now taking a big interest in it—coal and transport. They must in consequence, by reason of their sheer size, put a big strain on the market for trained time and motion study engineers, to mention only one group within work study. It is all to the good, therefore, that the British Productivite Council has been holding a work study conference in conjunction with the Factory Equipment Exhibition this week at Earl's Court. There are plenty of problems for the work study enthusiasts to discuss even in these days of success.

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Settlement at Birkenhead

The joiners' strike at the shipyard of Cammell Laird is over, after more than six months of the most futile stoppages ever to take place in British Industry. The men returned to work last week on the recommendation of the executive of the Amalgamated Society of Woodworkers after they had considered the report of the committee of inquiry appointed by the Minister of Labour in mid-March. Rarely have strikers been condemned in rounder terms: " the complete strike of joiners . . . . . was, in our opinion, wholly unjustified and was a clear breach of the first provision of the 1912 General Demarcation Agreement ".

Although the dispute was over who should drill holes in aluminium, and therefore one of demarcation between the joiners, the sheet metal workers and the drillers, it was complicated by an error made by the management in the early stages. They concluded an understanding with the joiners and the sheet metal workers without consulting the drillers, by which " it was agreed between the parties that the operation of drilling aluminium sheets and sections attached to wood after fitting by the sheet metal workers shall be joiners' work." The drillers objected and the management had no alternative but to recognise that they had made a mistake and that the understanding could not be carried out. The joiners immediately replied that they considered the company had repudiated their agreement, that their quarrel was with the management and not with the drillers and that they would withdraw their labour until the agreement was honoured.

The committee of inquiry say that the procedure laid down under the Demarcation Agreement is perfectly sound and appropriate in this case. In their view the existence of a demarcation between the joiners and drillers must have been obvious at once both to the company and to the joiners. There was therefore no need for a special agreement. The moral in this case is perhaps that no amount of rules or agrements are of much avail where goodwill is absent, and that when there is goodwill they are hardly necessary. Goodwill does depend on effective communications between management and labour.

★ ★ ★

Useful Arts

Now, desperately late in the day, this country is trying to raise its output of technologists. The recent Government White Paper promising £97 million for new facilities at technical colleges and allied purposes showed the urgency of the problem. A novel and imaginative gesture has now been made by Imperial Chemical Industries in an effort to swell the flow of good material into the sciences.

The company is offering 50 scholarships a year to universities, to enable arts students from schools which have not specialised in science to transfer to a science curriculum at university level. A special preliminary course is being prepared for 1956-57 at six universities, and scholars who wish to take it will have one year's costs of tuition and maintenance met out of the new bursaries. At the end of the year the student will choose whether he will proceed with his science studies (this will depend on his work over the preliminary course) or go back to arts. The scheme will cost the company about £35,000 a year.

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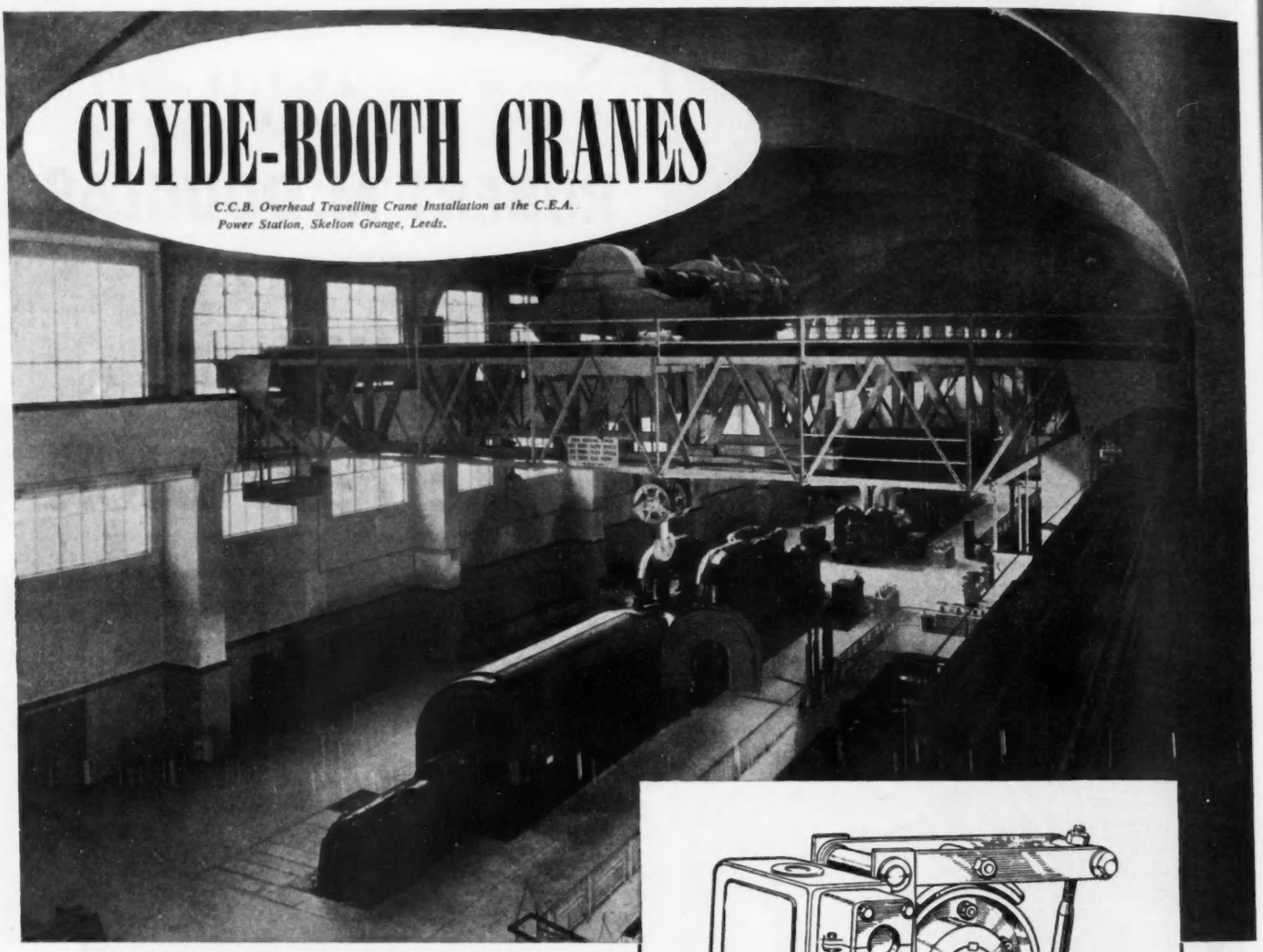

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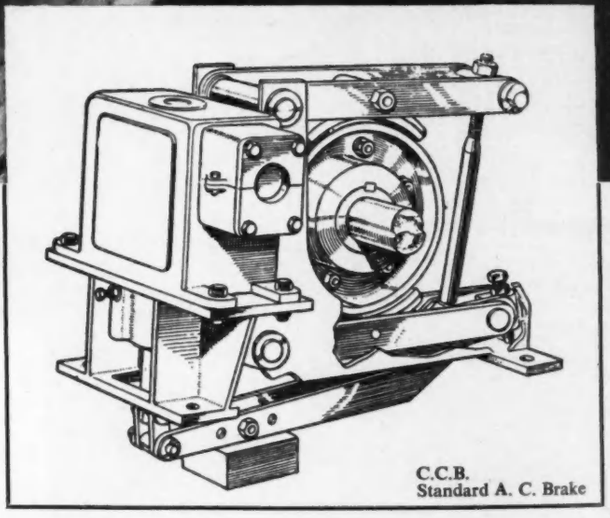

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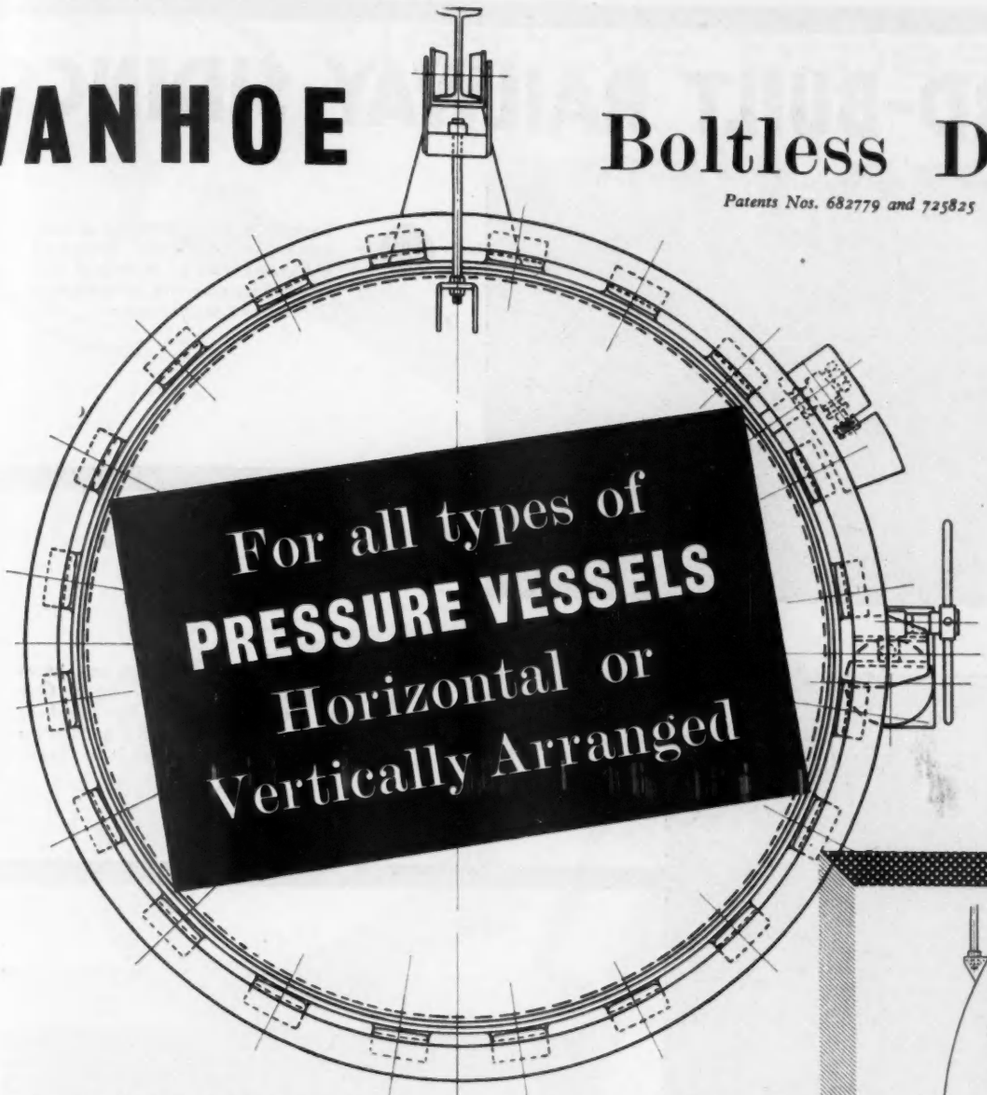

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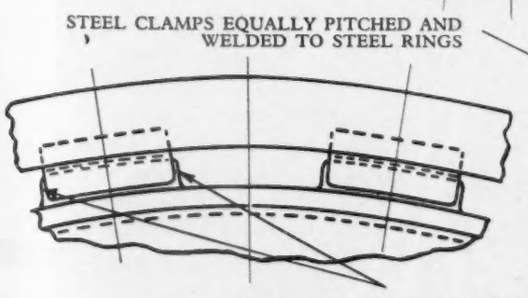

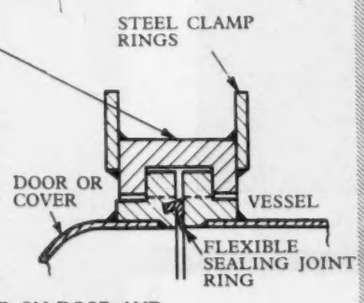

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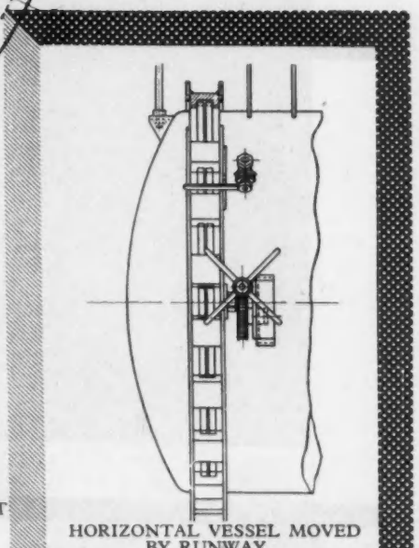

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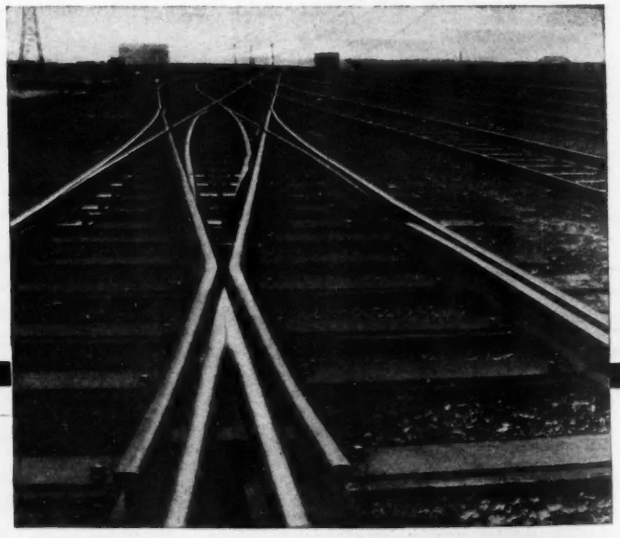

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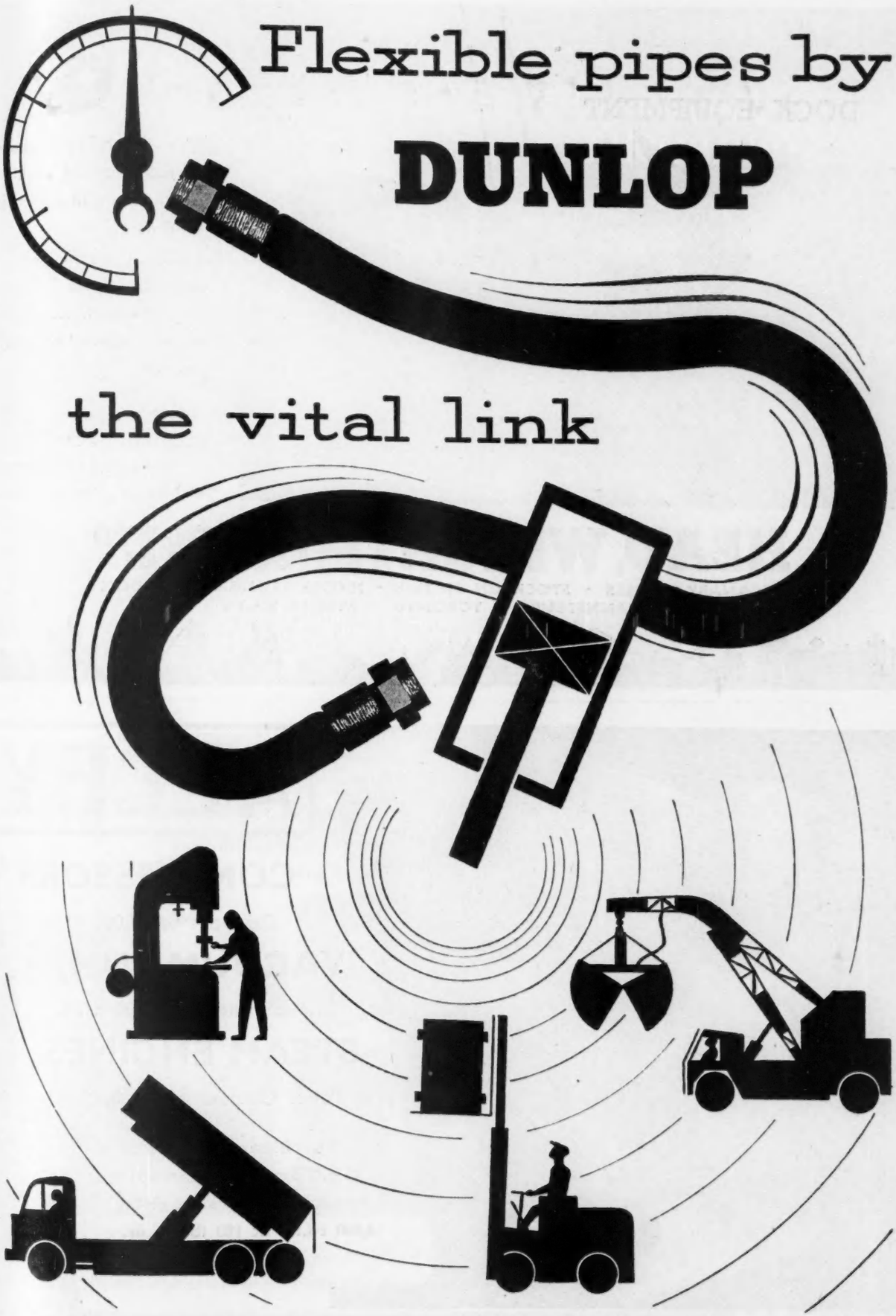

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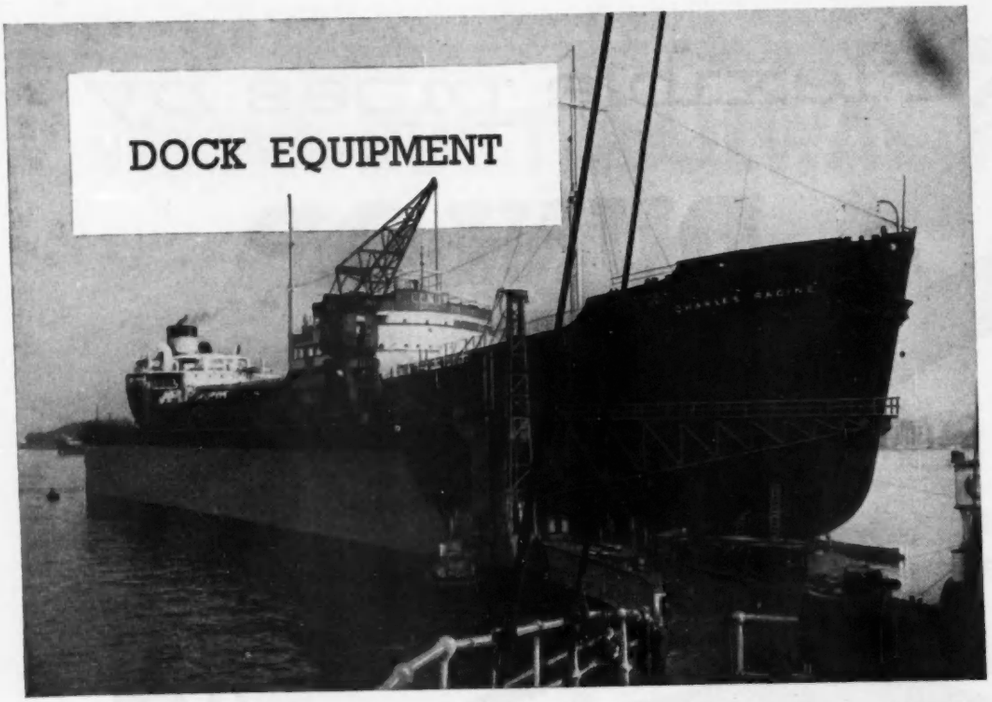

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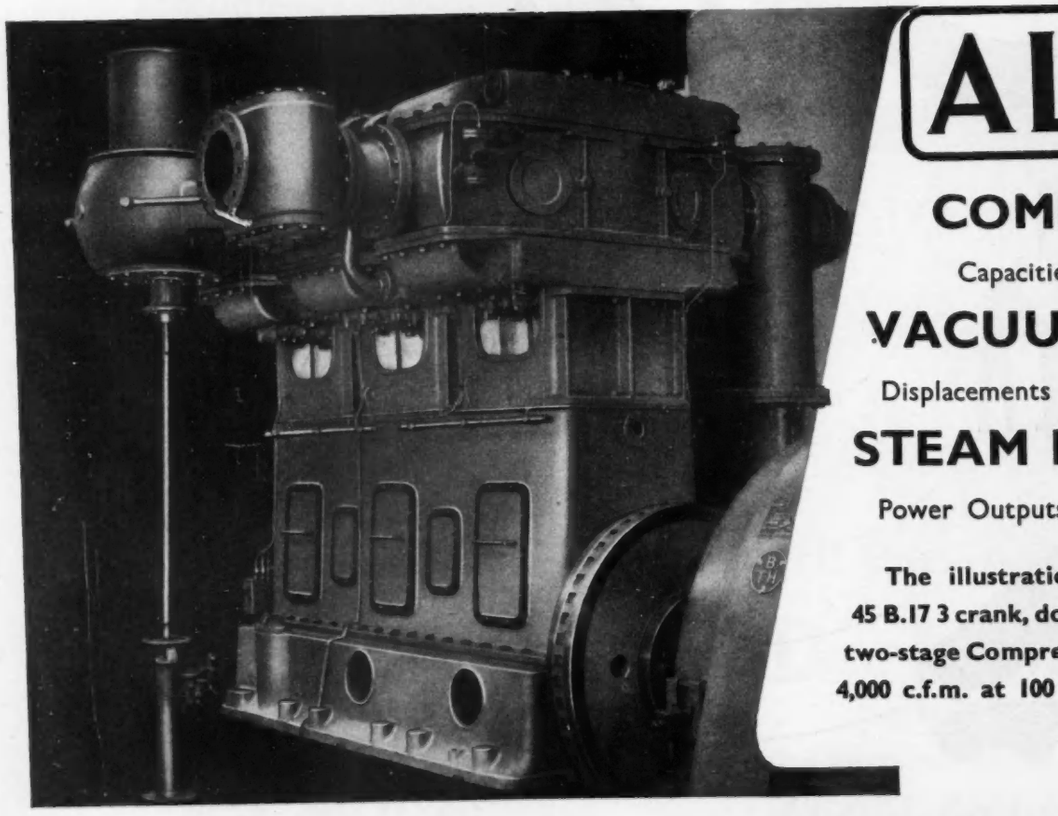

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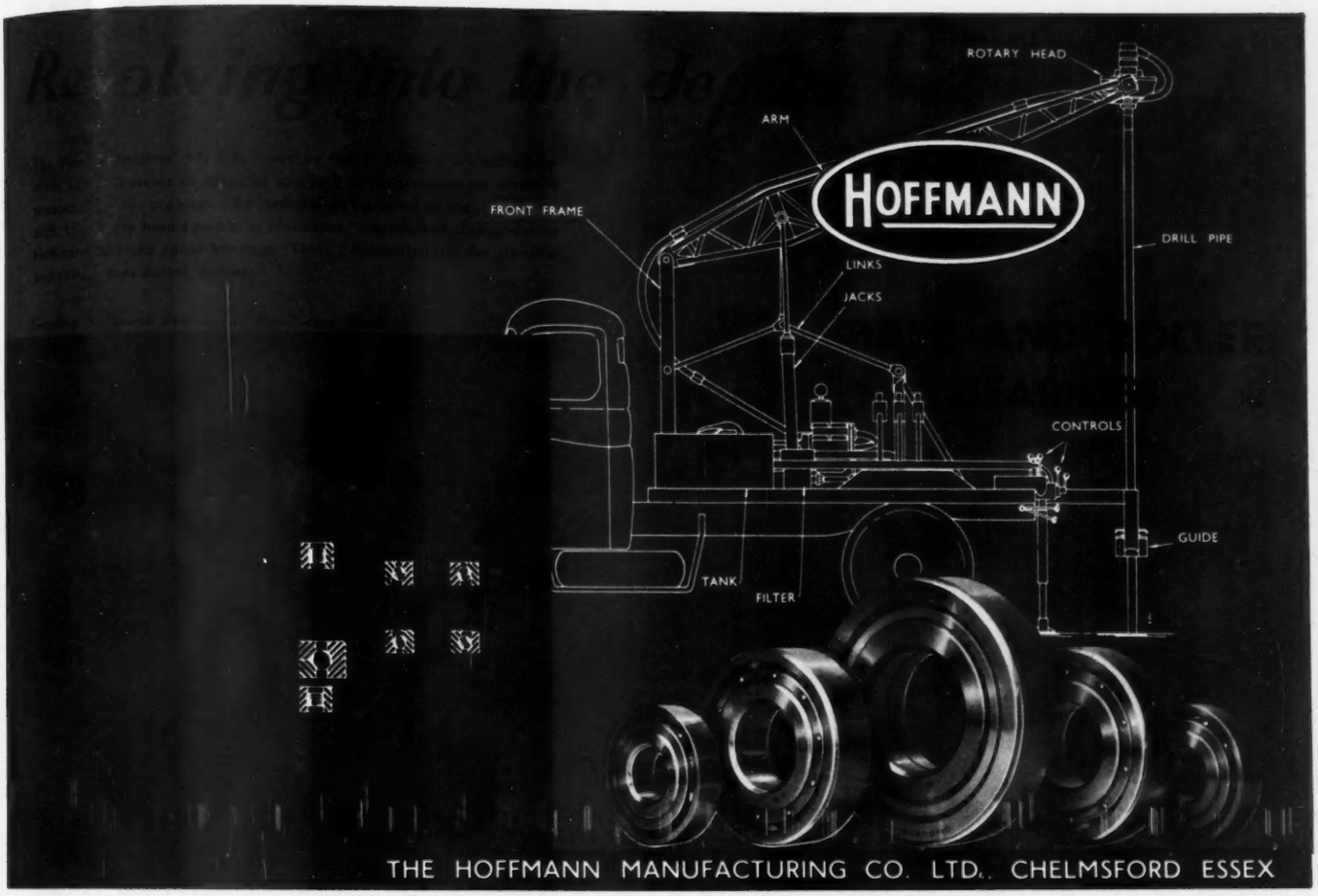

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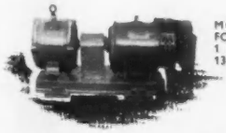

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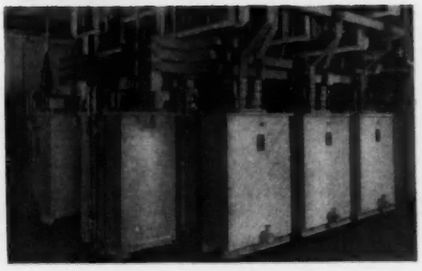
35 AMP. 24 VOLTS OUTDOOR TYPE BATTERY CHARGER

PART OF THE 150,000 AMP. 18 VOLTS RECTIFIER INSTALLATION FOR ELECTROLYTIC TINNING LINES TROSTRE WORKS STEEL COMPANY OF WALES



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ECC

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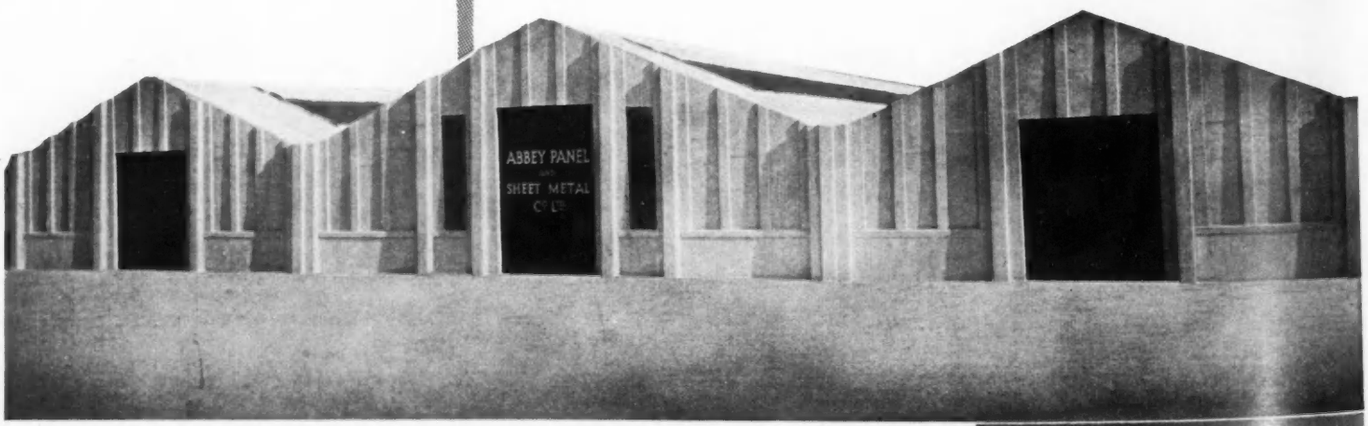
Current Beecham Achievements

"My Board are most impressed by the way you completed the existing factory within the stated time and I would add that we are highly delighted with the finished building.
It is very refreshing these days to get what you want, when you want it, without having to pay for a considerable amount of extras when you have got it. Your ability to execute this work so efficiently has helped us very considerably in meeting our own production commitments.
To meet additional requirements, I would appreciate it if you would quote me by return for extending the building by a further 20,000 sq. ft."

The extracts quoted are from a letter written by E. Loades, Esq., Managing Director of The Abbey Panel & Sheet Metal Co. Ltd., Coventry and Bedworth.

. . . completed to schedule this factory illustrates another successful Beecham contract, undertaken during a period of maximum production and against adverse weather conditions.

Concurrently Beecham Buildings have erected the largest prefabricated industrial building in this country ; a 200,000 sq. ft. factory in the Midlands. Their new ways of building allow Beecham to keep the pace on all their numerous contracts. For technical efficiency and well studied economy in Industrial Building you are advised to consult Beecham Buildings Limited.



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DEPARTMENT G

SHIPSTON-ON-STOUR, WARWICKSHIRE. Telephone: Shipston-on-Stour 315, 316 & 3287

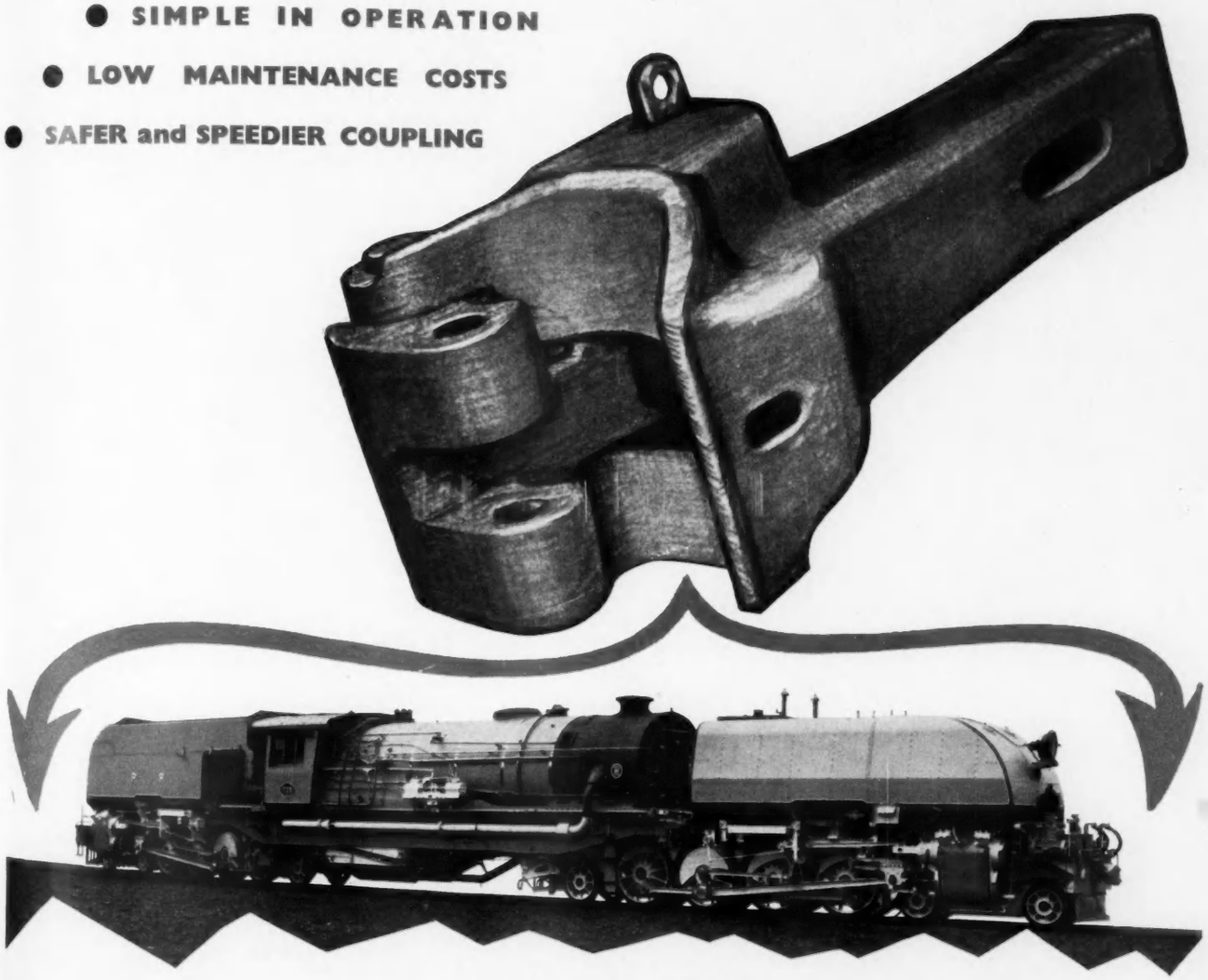
Why not consult us on your industrial building programme? We shall be pleased to advise you.

Beecham Buildings

AP. 211/58

ESC automatic couplers

- SIMPLE IN OPERATION
- LOW MAINTENANCE COSTS
- SAFER and SPEEDIER COUPLING



Photograph of Rhodesia Railways 20th class Beyer-Garratt Locomotive—By courtesy of Beyer Peacock & Co., Ltd.

Outstanding in design, the E S C " Alliance " automatic coupler is standard equipment on many railways throughout the World.

Made of a few parts of simple rugged design and embodying the latest improvements, this coupler meets all the requirements of up-to-date transportation systems which call for increased speeds, reduced maintenance costs and simplicity of operation.

ENGLISH STEEL CASTINGS CORPORATION LTD.

River Don Works, Sheffield.

A WHOLLY OWNED SUBSIDIARY OF ENGLISH STEEL CORPORATION LTD.

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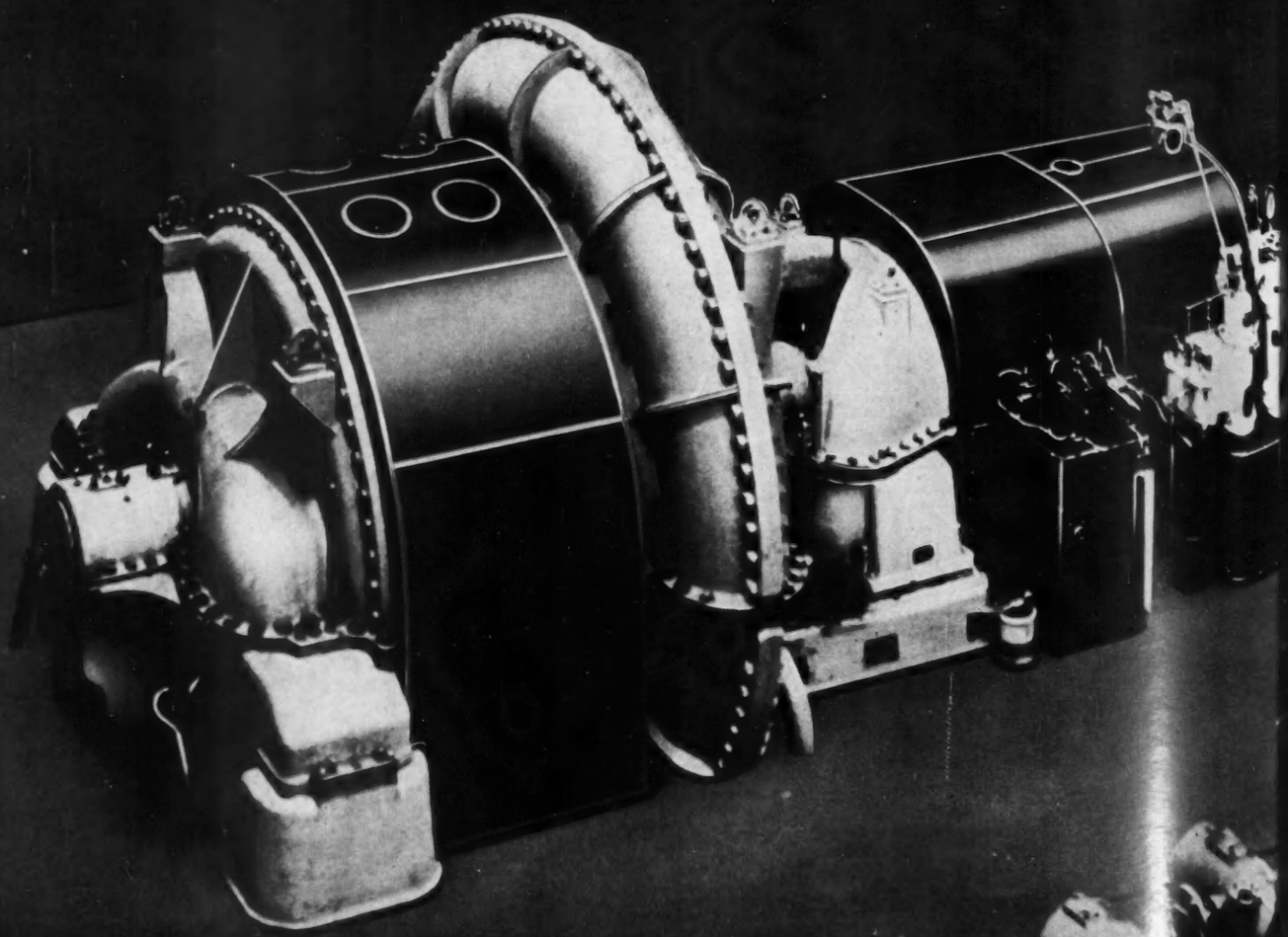
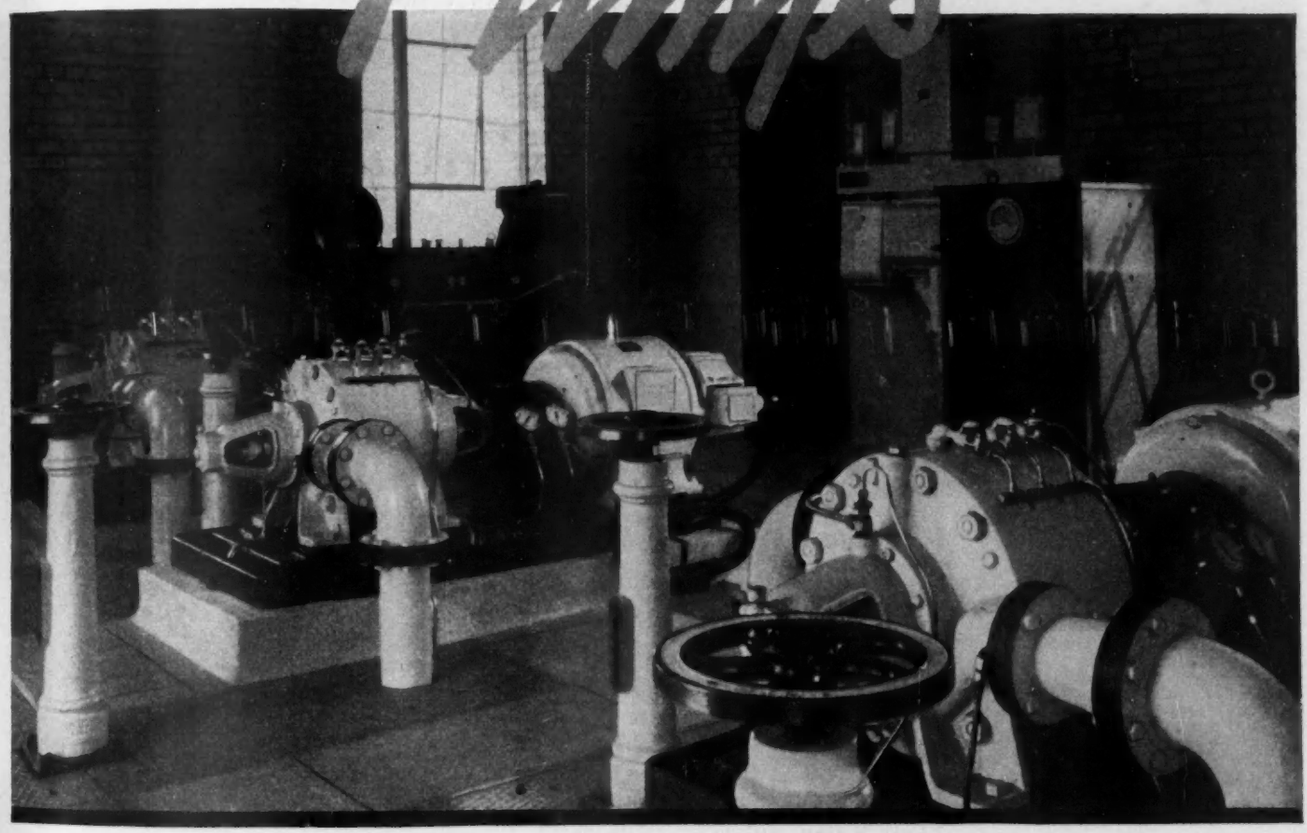


HEATON WORKS NEWCASTLE UPON TYNE 6

Gwynnes Pumps



The pumping machinery in the above photograph was supplied by Gwynnes Pumps Ltd to the instruction of Horace Rippin, Esq., A.M.I.C.E., A.M.I.Mech.E., A.M.I.W.E., Engineer and Manager to the East Elloe Rural District Council. The plant comprises two electrically operated automatic booster pumps and also one diesel engine driven booster pump. Each pump delivers 417 G.P.M. against a head of 200 ft.

GWYNNES PUMPS

GWYNNES PUMPS LTD

HAMMERSMITH LONDON W 6

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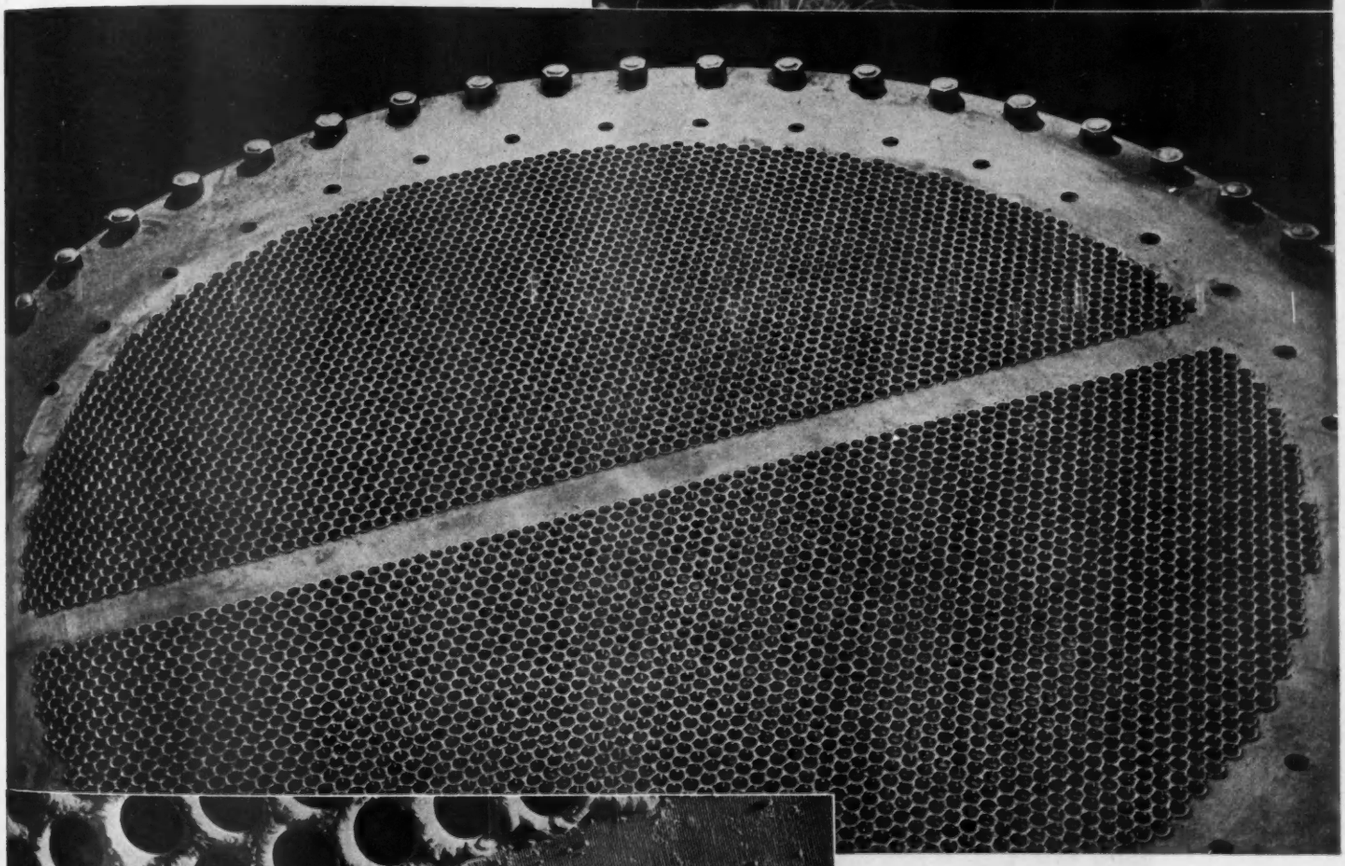

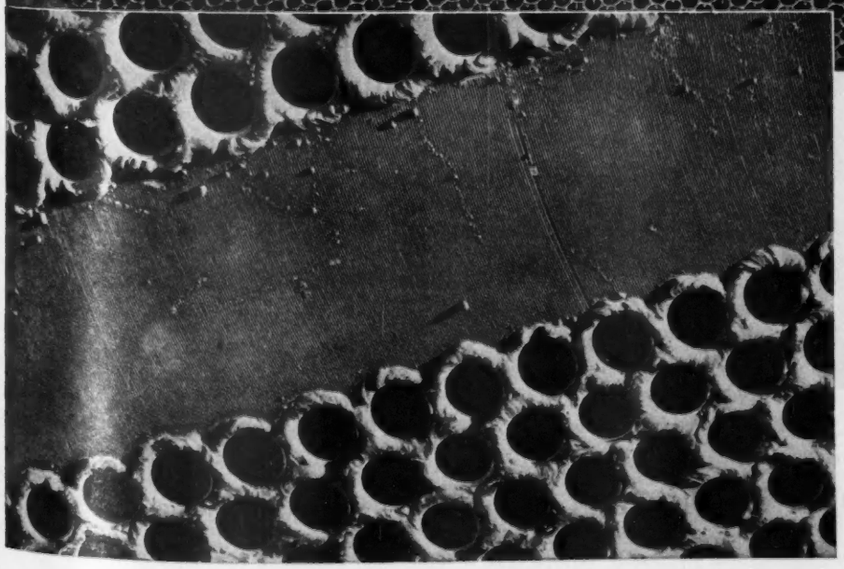

Tube plate for a Heat Exchanger, incorporating 5518 tubes ¾ in. dia., and involving 1078 footage of welding.

Harvey

G. A. HARVEY & CO. (LONDON) LTD
Woolwich Road · London, S.E.7
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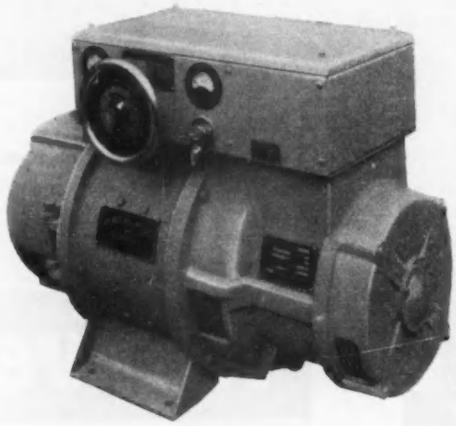
welding-sets

Reyrolle welding-sets can be fixed on production lines or mobilised for out-door constructional work



300/200-ampere AC/DC type-B single-operator welding generator set with concentric dual control.

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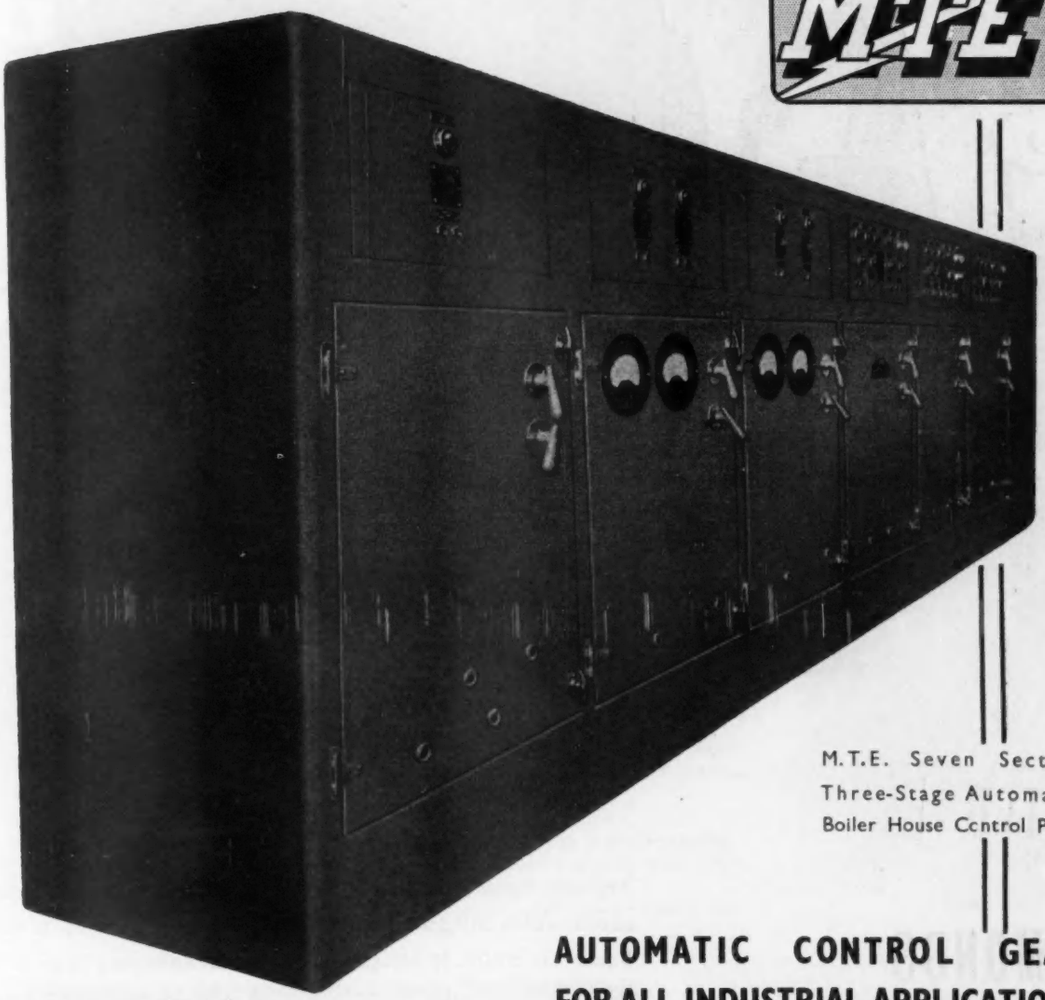

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Boiler House Control Panel

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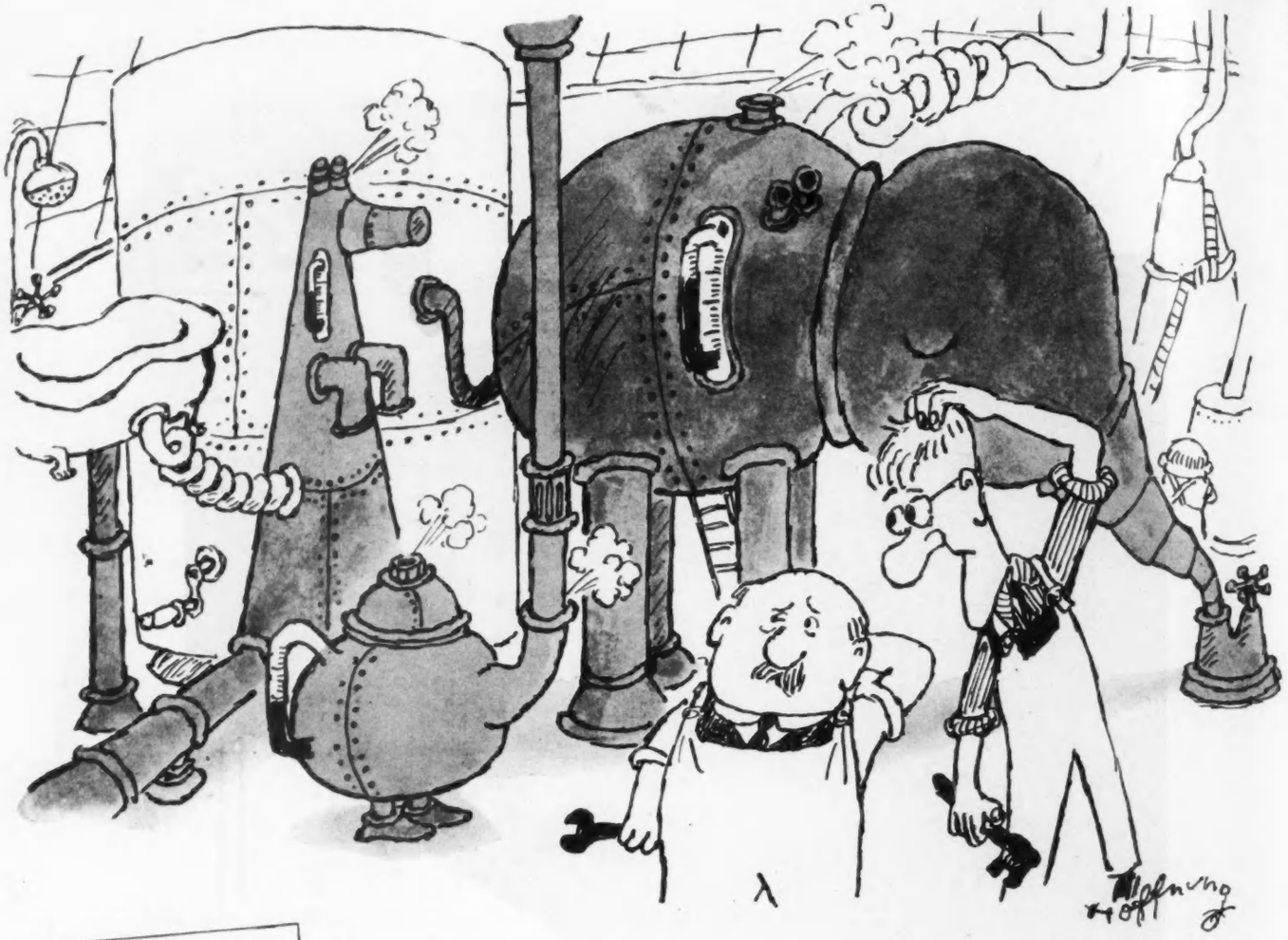

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Any size, shape or variety of tank can be fitted with a Simmonds contents gauge, which will indicate accurately the head, weight or volume of the liquid it contains. Readings of a number of tanks may be given on one dial; liquid level controllers are also available. In fact we have the equipment to measure any kind or quantity of liquid anywhere. We also have the engineers to install, calibrate and service our gauges and give you any technical advice you need.

Simmonds gauges are Admiralty approved, and meet the requirements of Lloyd's Register of Shipping and the Ministry of Transport.

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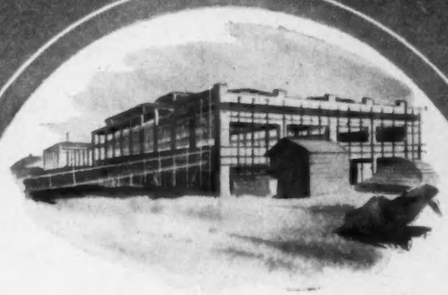


GOODYEAR

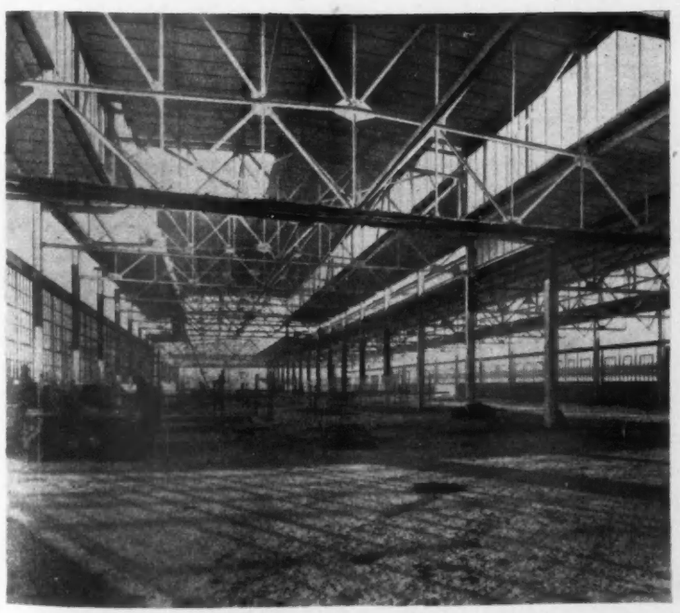
Another Rubery Owen job is shown here—the factory extension erected for the Wolverhampton plant of the Goodyear Tyre and Rubber Company.

Double storey type building, 380ft. long, 100ft. wide, with an annexe 100ft. long, 25ft. wide.

Height to eaves, 35ft.

Roof covered with V beam sheeting. Lights of patent glazing with 30ft. opening geared windows.

Steelwork totals approximately 680 tons.



DESIGN, FABRICATION ERECTION— every detail is taken care of by Rubery Owen. This complete service applies to single and multi-storey buildings, and includes riveted and welded steel structures.

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GENERAL DESCALING FREES BLOCKED SEWERS

after Tip Blaze in Huddersfield

Photos by "The Huddersfield Examiner"

*GENERAL DESCALING M.C.E.**
*(*Mechanical and Chemical Engineer)*

Scene of General Descaling's operations at Huddersfield.

NEW ROLE FOR VETERAN OF SCALE WARS

Assault Detachment, Huddersfield, Friday. *Shock troops under General Descaling, veteran campaigner of anti-scale warfare have been actively engaged in ridding two Huddersfield sewers of the General's old enemy, chemical wastes.*

When flames reached highly inflammable materials in a local tip blaze, burning lava-like material flowed into nearby sewers where it hardened to cause a complete blockage.

Urgent appeal for relief was sent to General Descaling at his Headquarters in Worksop. Accompanied by highly trained forces with the latest equipment, he was soon at the front and had launched a counter-offensive to clean up the blocked 12in. and 27in. piping. The attack was a complete success and the sewers were freed for a fraction of the cost of replacement—the only alternative.

"WE ATTACK ANY KIND OF STOPPAGE"

Jobs like this which give Drainage Authorities real headaches make the General smile in anticipation of a fight he knows he will win. The harder it is, the more he likes it.

Forces are also available to descale gas and water mains at a fraction of their cost of replacement. Even the toughest deposits are eliminated with speed and safety, leaving a finish as good as new. There's a minimum of cutting and disturbance of services; and no damage to pipes and ferrules.

Any size of pipe in any material or of any construction can be attacked, whilst bitumen relining is available to consolidate the position after scale has been routed.

Send for details of the General's services — today!

GENERAL DESCALING CO. LTD. H.Q. WORKSOP NOTTS. TEL 3211-3

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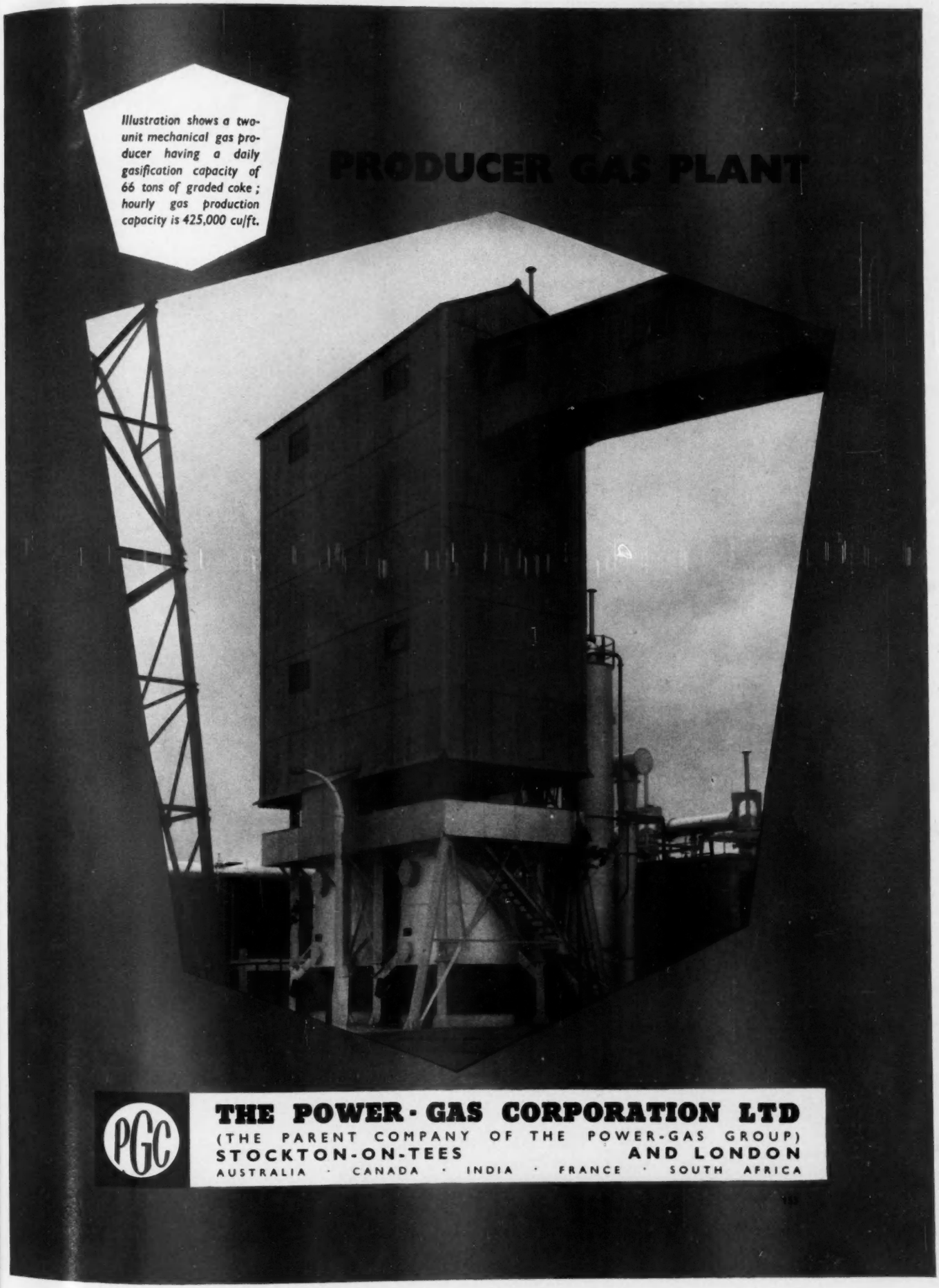
PRODUCER GAS PLANT
Illustration shows a two-unit mechanical gas producer having a daily gasification capacity of 66 tons of graded coke; hourly gas production capacity is 425,000 cu/ft.

PGC

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(THE PARENT COMPANY OF THE POWER-GAS GROUP)

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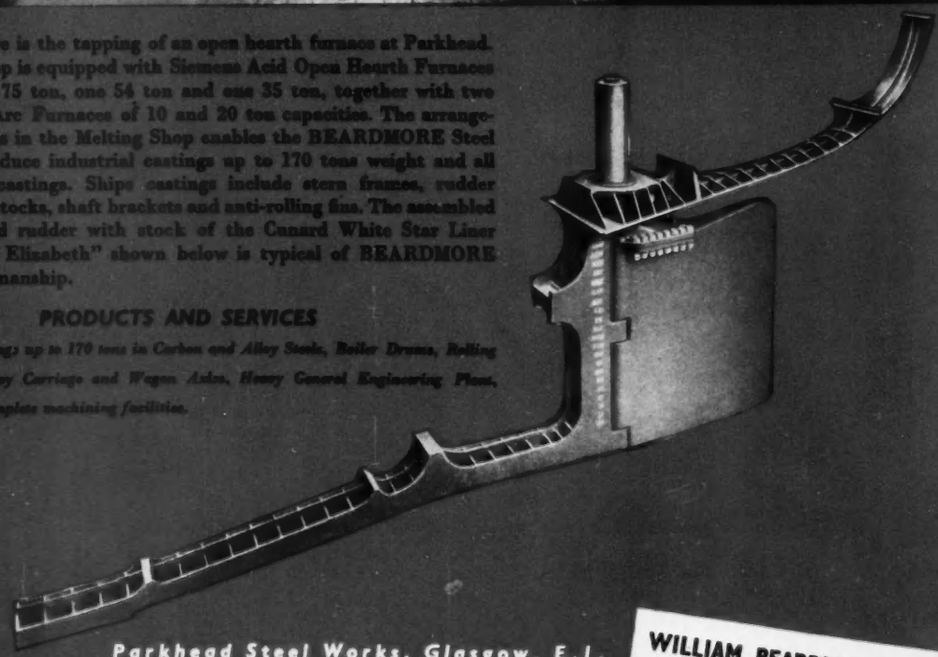
BEARDMORE

STEEL

Illustrated above is the tapping of an open hearth furnace at Parkhead. The melting Shop is equipped with Siemens Acid Open Hearth Furnaces including three 75 ton, one 54 ton and one 35 ton, together with two basic Electric Arc Furnaces of 10 and 20 ton capacities. The arrangement of furnaces in the Melting Shop enables the BEARDMORE Steel Foundry to produce industrial castings up to 170 tons weight and all heavy marine castings. Ships castings include stern frames, rudder frames, rudder stocks, shaft brackets and anti-rolling fins. The assembled stern frame and rudder with stock of the Cunard White Star Liner R.M.S. "Queen Elizabeth" shown below is typical of BEARDMORE Foundry craftsmanship.

PRODUCTS AND SERVICES

Forgings and Castings up to 170 tons in Carbon and Alloy Steels, Boiler Drums, Rolling Mill Plant, Railway Carriage and Wagon Axles, Heavy General Engineering Plant, Armaments and complete machining facilities.



Parkhead Steel Works, Glasgow, E.1.

WILLIAM BEARDMORE & CO. LIMITED

Telephone: BRIDGETON 1881-9 Telegrams: BEARDMORE Glasgow.
London Office: 3 St. James's Square, S.W.1. Telephone: Whitehall 6844
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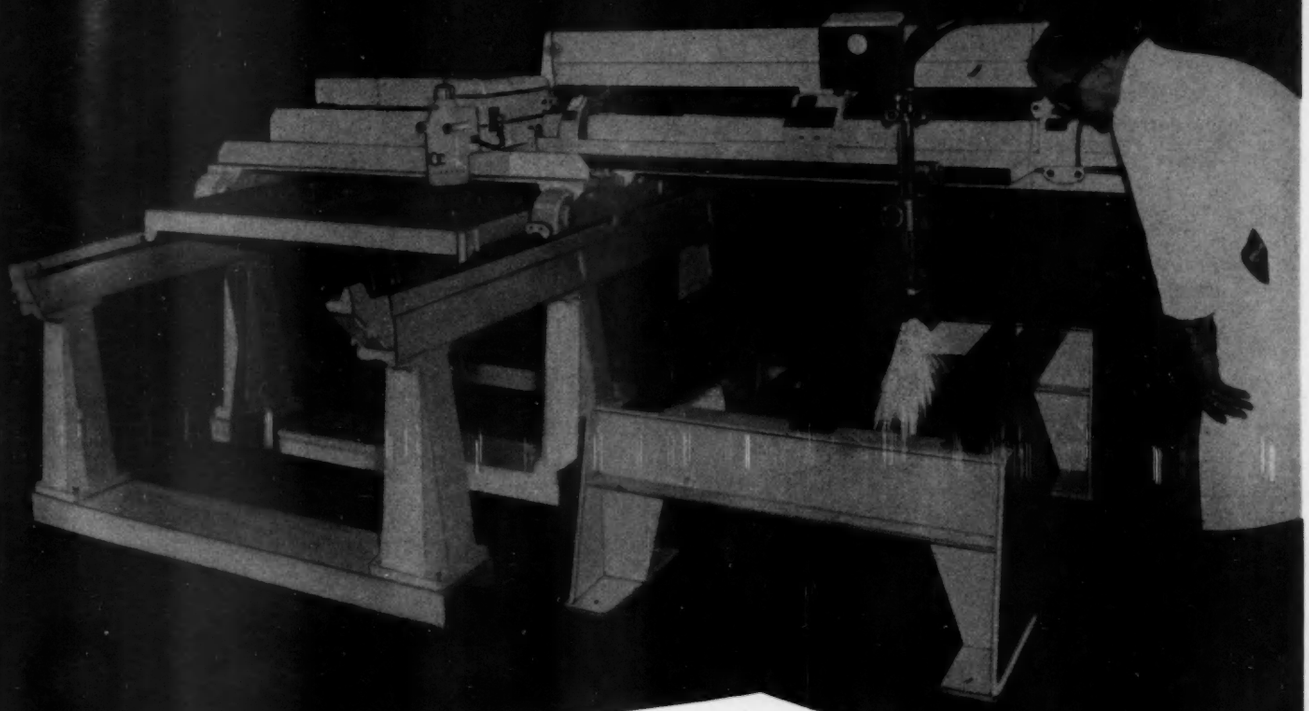
The Torch of Industry



And Now! the BISON

—the latest development in profile cutting machines

The BISON is the result of an intensive development programme having as its background British Oxygen's up-to-the-minute knowledge of all kinds of gas cutting machines.

THESE ARE ITS SPECIAL FEATURES:

(1) THYRATRON SPEED CONTROL: For precise regulation of cutting speed—the known essential for high quality cutting.

(2) INTERCHANGEABLE TRACING HEADS: Tracing Heads to work from steel templates, wood templates, or drawings—all quickly interchangeable are available for this machine.

(3) EXTENSIBLE CUTTING LENGTH: In addition to being available in two cutting widths of 42″ and 84″ the longitudinal cut is extensible up to any length by the addition of extra sections of track in increments of 42″.

(4) UP TO THREE CUTTERS: Can be mounted on the boom for multiple cutting.

(5) USES ALL FUEL GASES: The BISON will operate on Acetylene, Propane or Coal Gas.

BRITISH OXYGEN

British Oxygen Gases Limited, Industrial Division, Bridgewater House, St. James's, London, S.W.1

12 MVAr CAPACITOR BANK FOR BRITISH CELANESE LTD.

J. & P. *supply the largest single bank in the country.*

With the introduction of a kVA maximum demand tariff for their Spondon Works, British Celanese Ltd. were faced with the problem of improving the overall power factor from 0.8 to 0.97. For various reasons it was decided that the capacitors should be installed on the high voltage system, and J. & P. were commissioned to supply the required 12 MVAr bank. The installation comprises six-2 MVAr sections each containing six-333 kVAr single-phase units star connected for operation on 6.6 kV system. The sections are independently switched to provide flexibility. The units were given a special outdoor corrosion resistant finish which included aluminium spraying by the Metallisation process. The urgent nature of the scheme demanded adherence to a quick delivery schedule, which was achieved.

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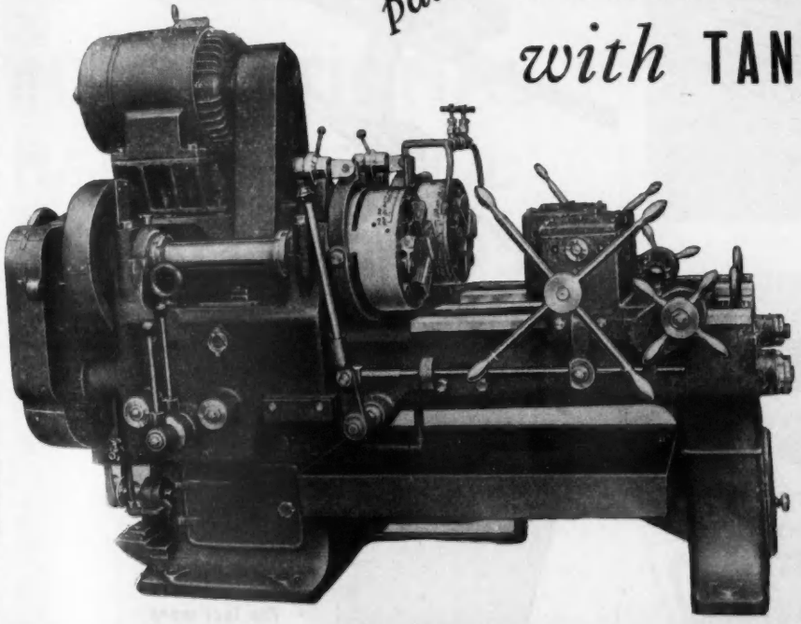

The illustration shows our 2½ in. Double Head Bolt Screwing and Nut Tapping Machine which will cut either right or left hand threads (or both at the same time). It is fitted with our patent Tangential Die Heads, which open automatically when any predetermined length has been screwed, and with two Leading Screws extending the full length of the bed, which ensure absolute accuracy of pitch. 16 in. can be screwed at one setting.

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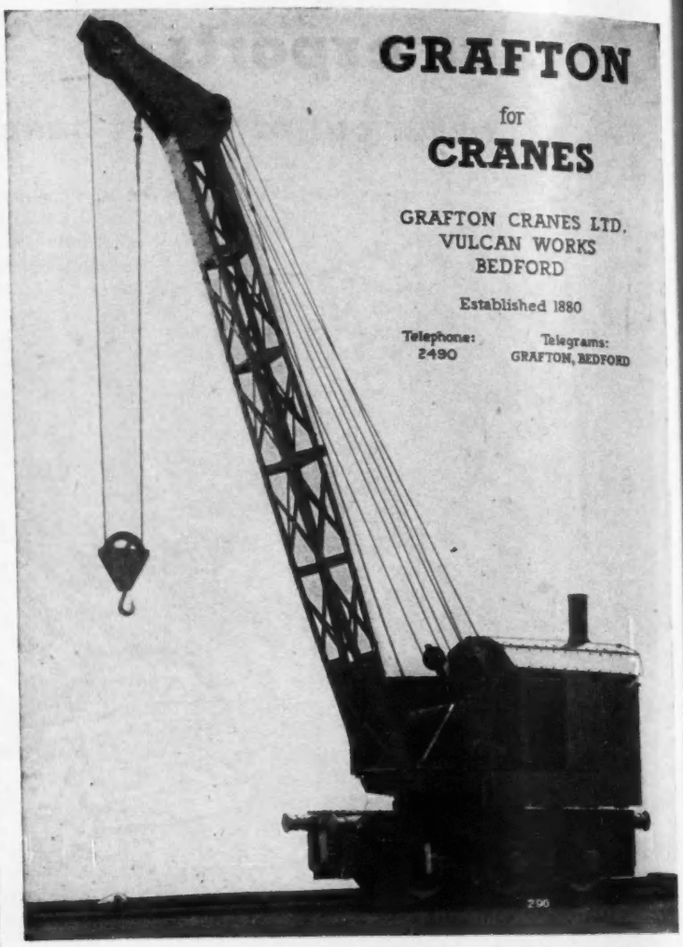

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An Aerial Ropeway may be the answer to your transportation problems.
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Don't miss it !

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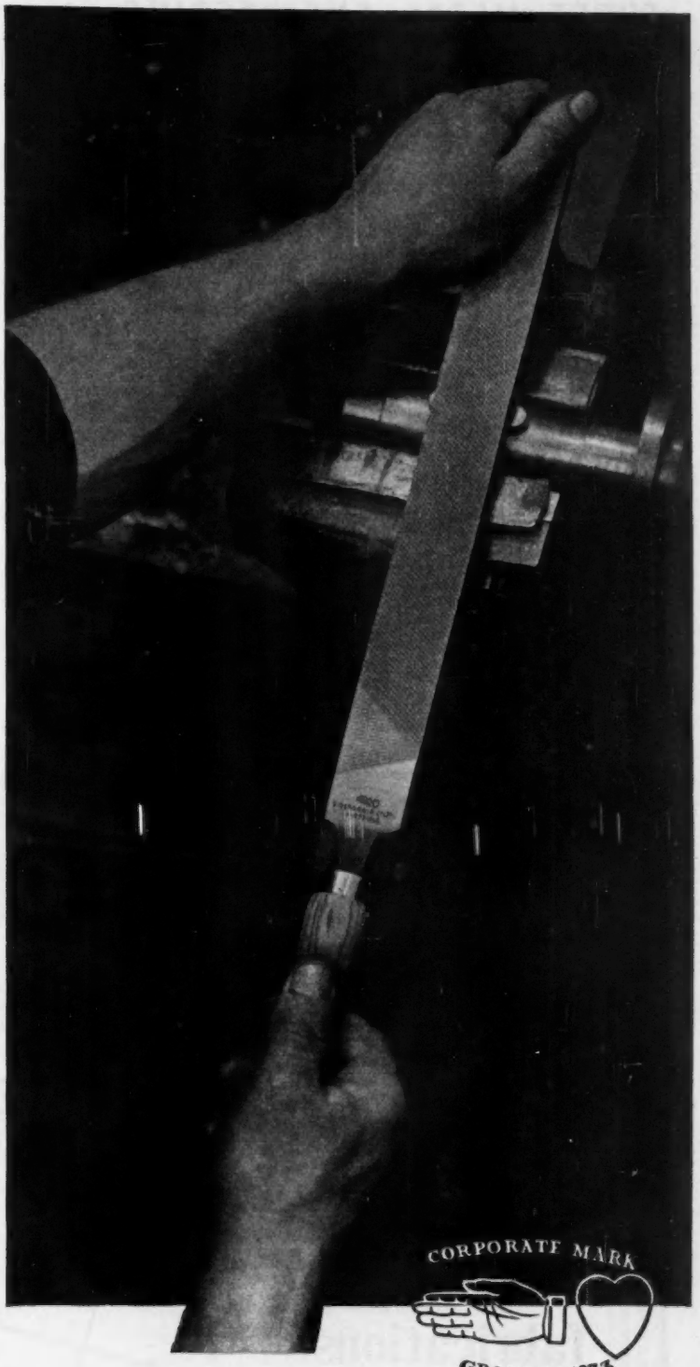
Organized by The Machine Tool Trades Association, Victoria House, Southampton Row, London, W.C.1.



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Real craftsmen appreciate the consistent high quality of Osborn Best Warranted Steel Files and Rasps.

The steel from which they are made is selected with great care, and every process of manufacture is rigidly controlled to ensure the production of first class tools.

Stocks of usual types, sizes and cuts available or immediate delivery.

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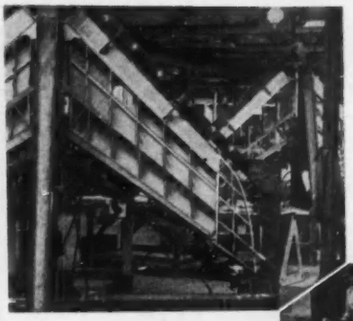
CLYDE STEEL WORKS, SHEFFIELD.

SHEET METAL ENGINEERING...
for the AIRCRAFT INDUSTRY



★ Our photographs show sections of our extensive works where work is in progress on complete tailplane assemblies for the famous Hawker Hunter jet fighter aircraft.

★ Our long experience and modern equipment, coupled with our high quality and precision workmanship, enable us to offer a specialised service to the aircraft industry. We can make prototype components or equipment and can also produce the tools to do the job. Our spacious workshops can also handle quantity production.

Full information available from Dept E.1/56

E. G. Brown & Co. Ltd

WEST ROAD, TOTTENHAM, LONDON, N.17.

What blows up must come down

And what blew up in this instance was an autoclave. Installed in a chemical works, it took the roof off the building, and flung 235 lb. of metal sixty yards with fatal effect.

What Vulcan say about it

The foregoing proves, that danger can lurk in every kind of factory plant. Boilers, lifts, hoists, cranes — are all liable to accident. That's why regular inspection by specialist engineers is essential. Vulcan's Engineer-Surveyors are the experts. It's their job to detect the defects, to ferret out the flaws, to point out whatsoever is wrong and how to put it right. Safety first is Vulcan first.

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THE Vulcan
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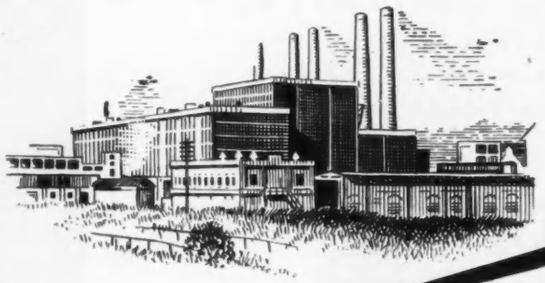
Vulcan Inspects — and Protects

Specialists in the construction of all types of mild steel fabrications



When you require plant of bolted, welded or riveted construction contact Markland Scowcroft—manufacturers to individual specifications in almost any thickness of mild steel plate.

Also consult Markland Scowcroft for Mechanical Tubing and Storage Tanks.

Markland Scowcroft Ltd

COX GREEN WORKS, BROMLEY CROSS, NR. BOLTON

Telephone: EAGLEY 600 (5 lines)

M 122

FIRTOP MOTORISED VALVES, with pre-set automatic operation, provide close control of fluid flow and eliminate pipeline shock-loading. For 2in. to 8in. bore pipelines, and for all standard voltages. Layout and control arrangements to suit specific applications.

•

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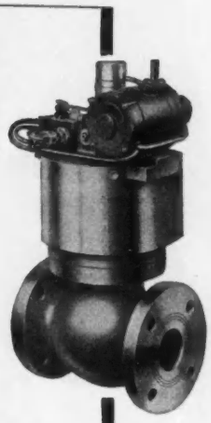

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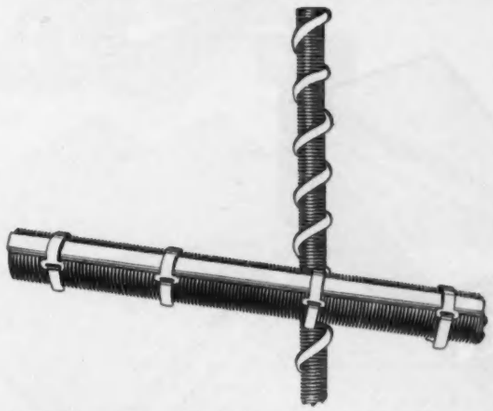

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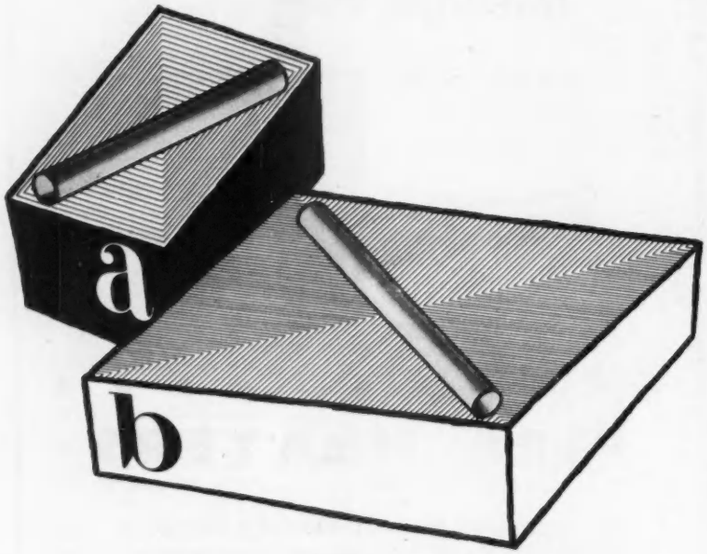

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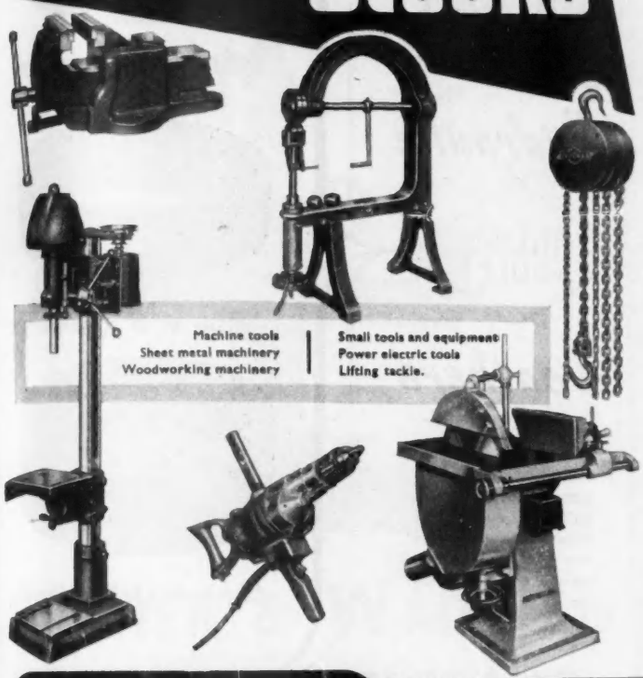

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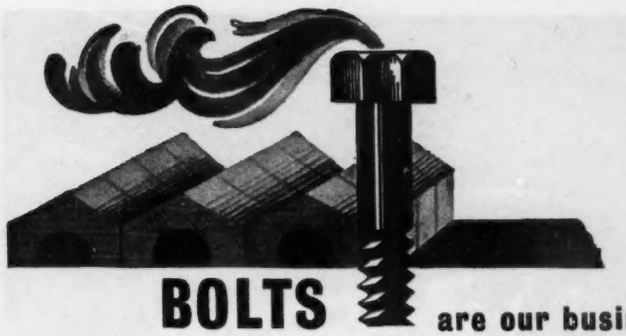

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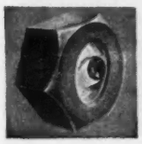

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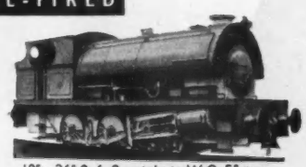
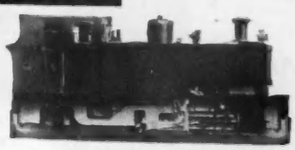


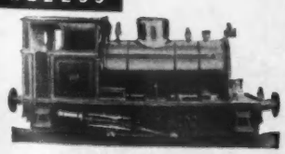
18" x 26" 0-6-0 weight in W.O. 51 tons

OIL-FIRED



13" x 16" 0-4-2 weight in W.O. 29 tons

FIRELESS



12" x 18" 0-4-0 weight in W.O. 18 tons

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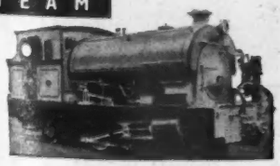

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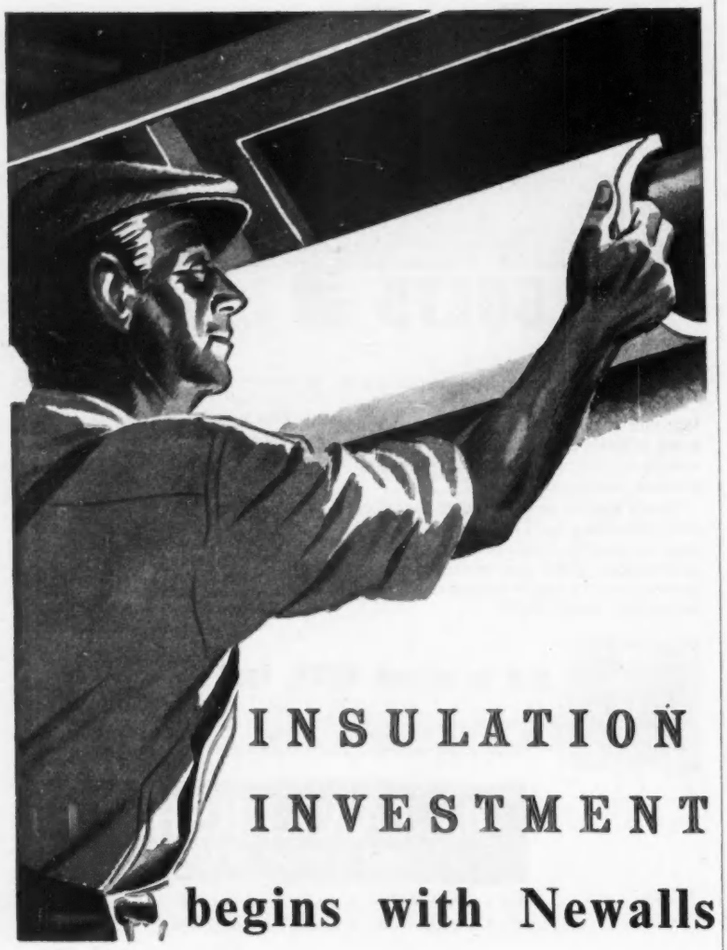

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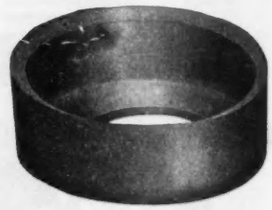

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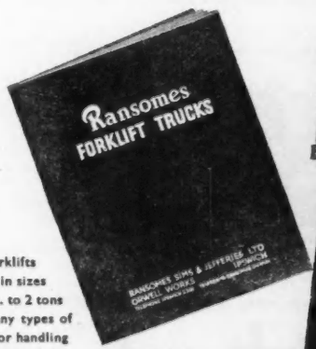

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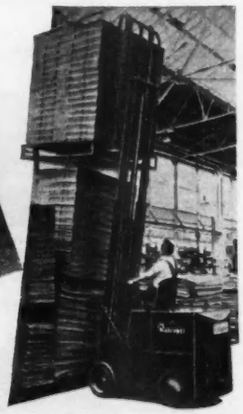

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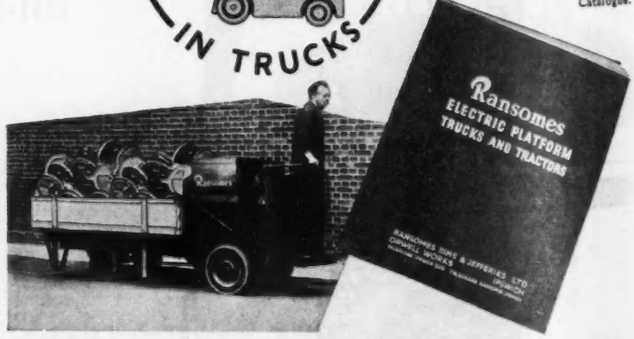

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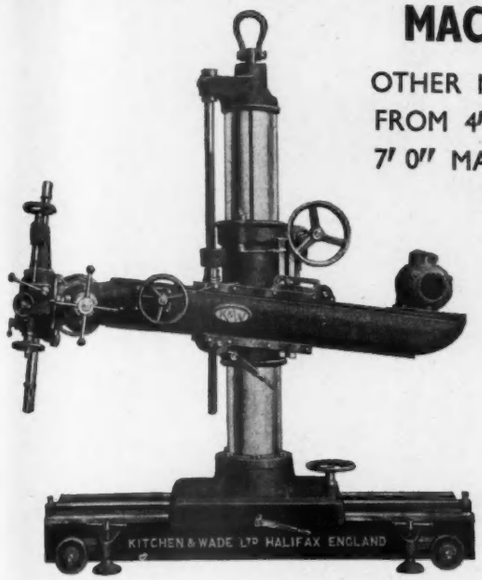

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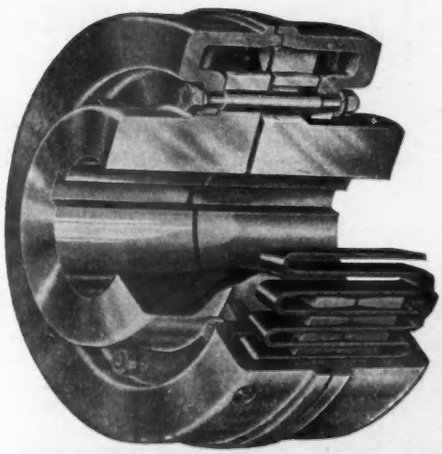

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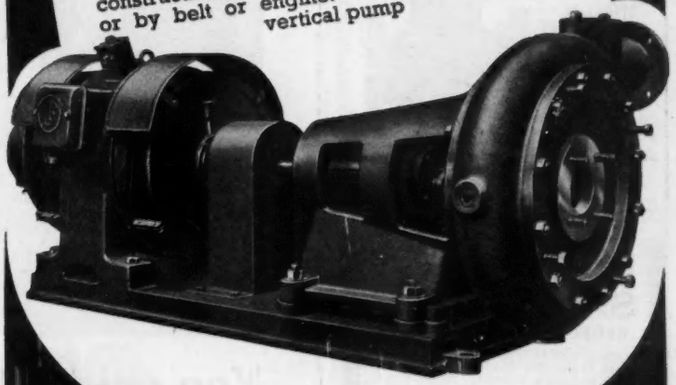

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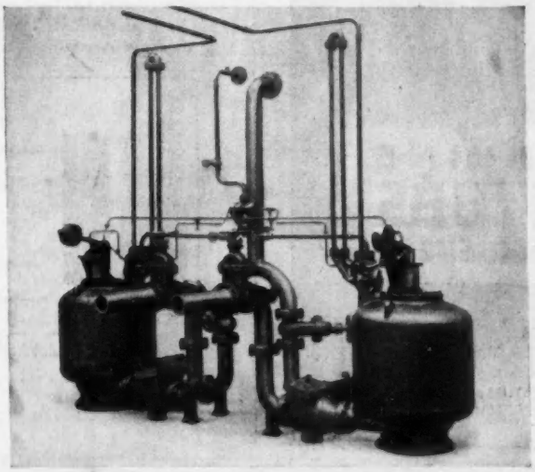

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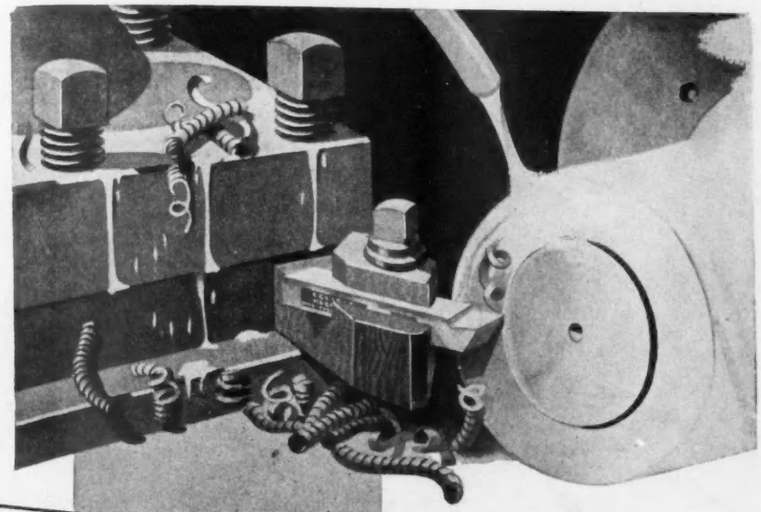

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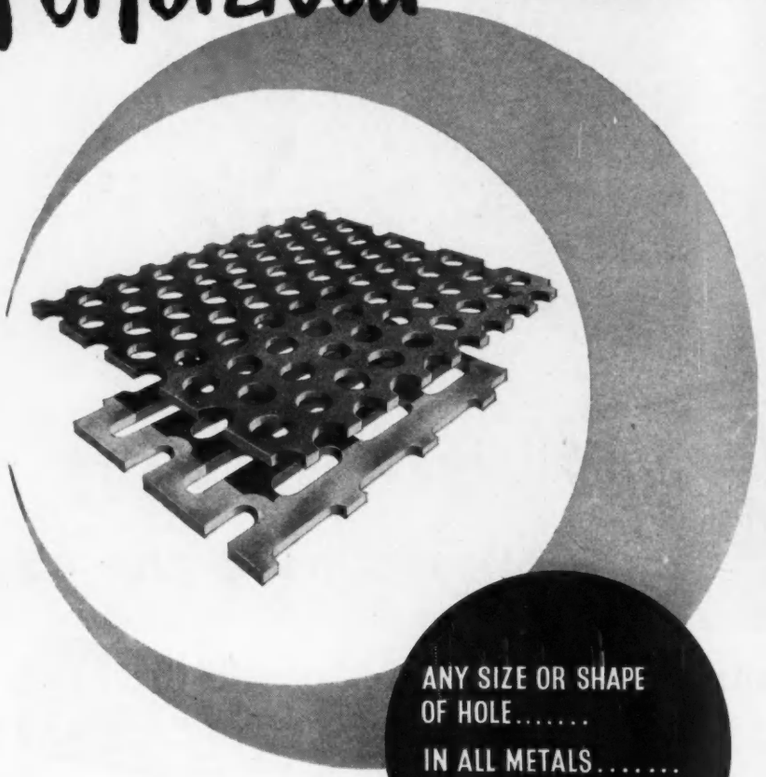

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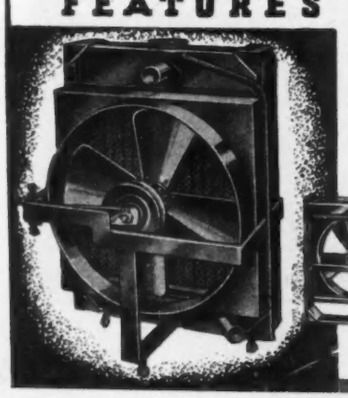

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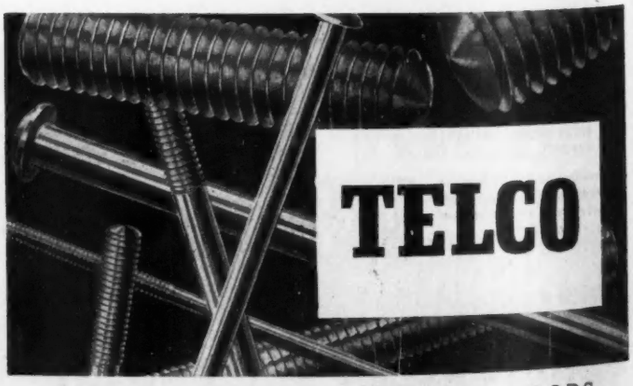

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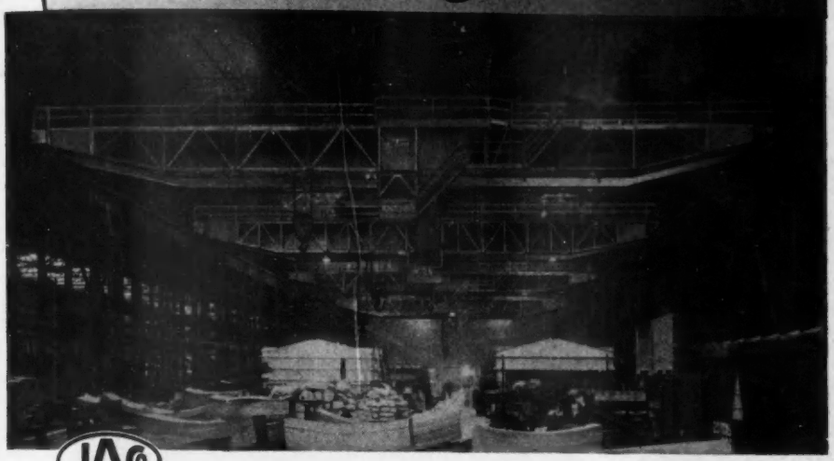

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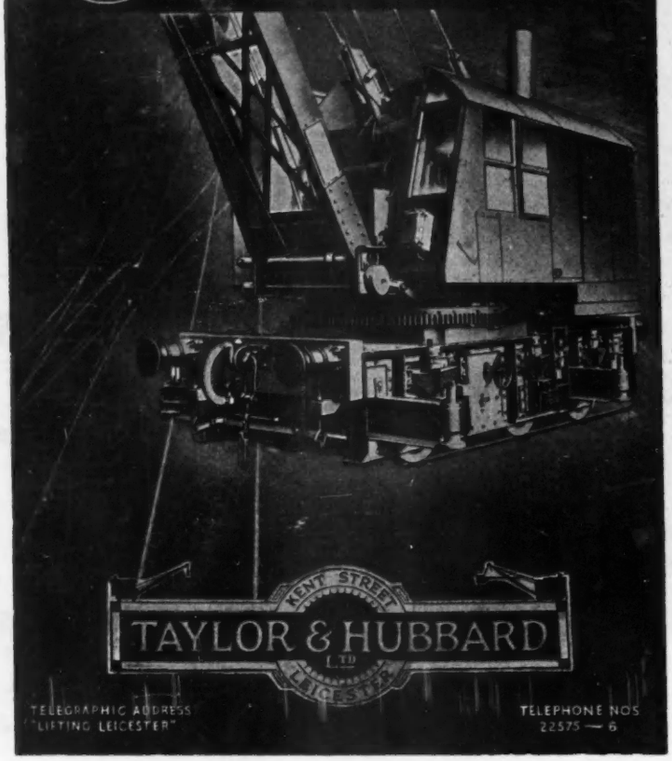

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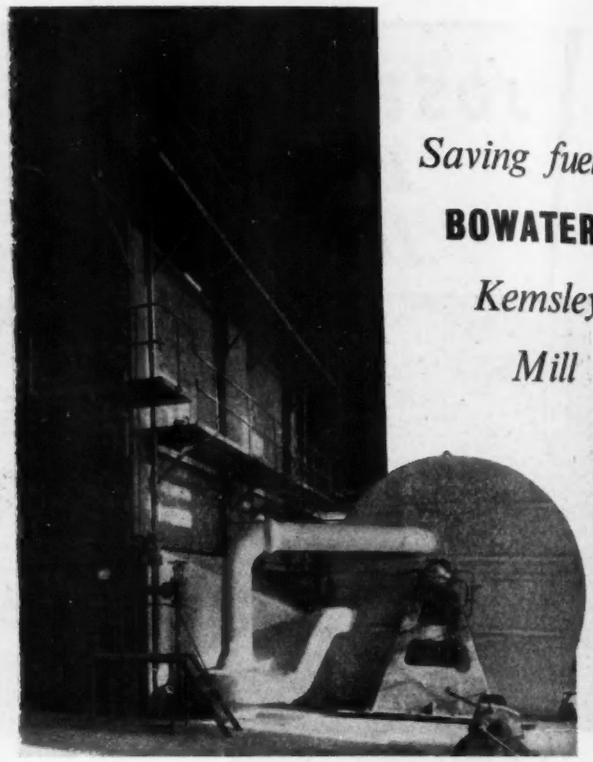

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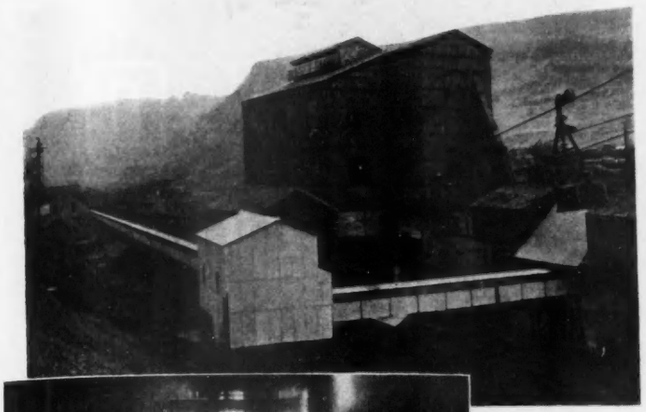

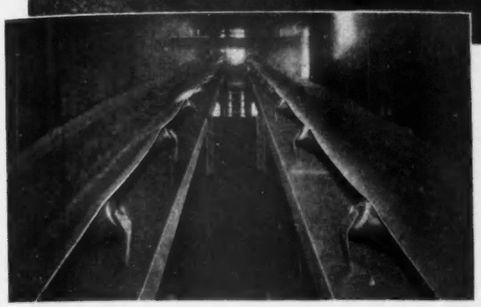

(Above) Troughed Belt Conveyor, Gantries and Corner Transfer House at Fernhill Colliery, South Wales.

(Left) Twin Troughed Rubber Belt Conveyors feeding small Coal and Rubbish to Washery & Bucket Elevators at South Celynen Colliery, South Wales.

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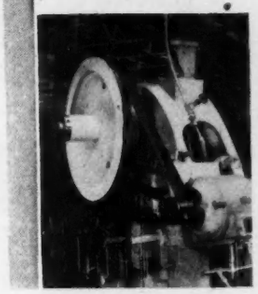

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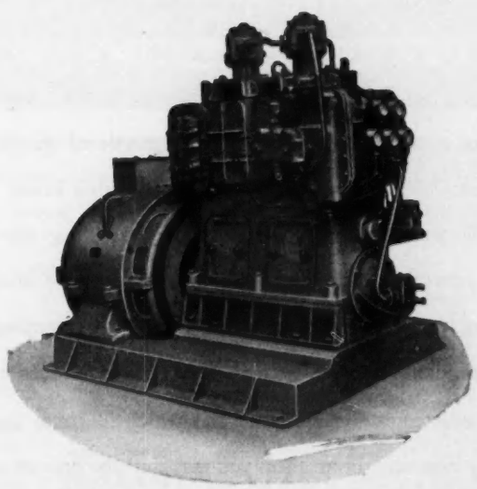

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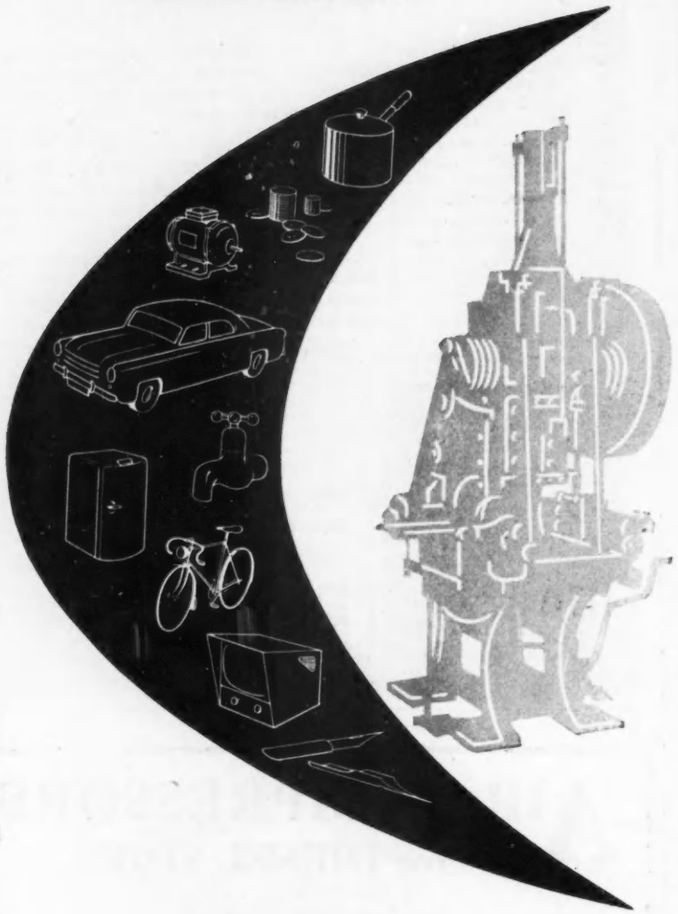

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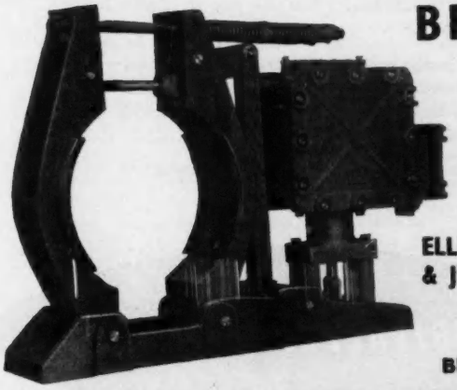

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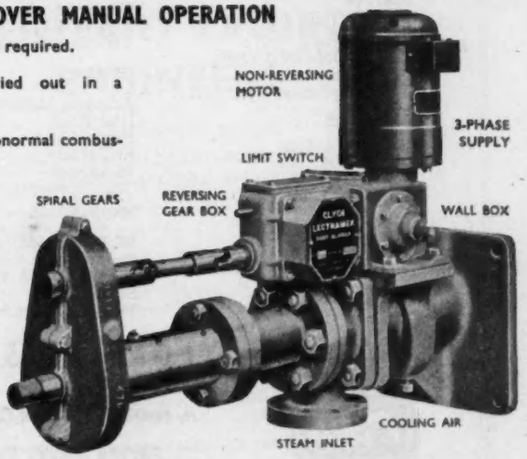

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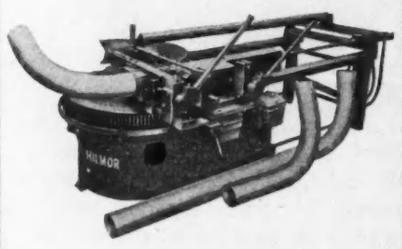

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Engineering Company has openings for **DESIGNERS, DETAILERS, CHECKERS,** all phases Tool, Machine, Product, and Automation—Contact us if you are planning to live in the United States. We are located 16 miles from Detroit, Michigan, and have long term programme of Aircraft design, and engines of the future. Salaries up to £40/£50 per 40-hour week to top grade Draughtsman Designer. Living accommodation can be arranged. For interview in London, write with qualifications, to BOX L 12, Offices of ENGINEERING.

GEORGE WIMPEY & CO. LTD.
require at their head office a
CHIEF MECHANICAL ENGINEER
for constructional works.

Applicants must have experience to qualify them for the administration of a department for the construction of large works in oil refinery and chemical engineering.

Commencing salary will be
£3000 per annum,
and in addition generous pension terms will be offered.

Applications in confidence to—
GEORGE WIMPEY & CO., LTD.,
HAMMERSMITH GROVE,
LONDON, W.6. K 994

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD
ARMAMENTS DIVISION

PROJECT ENGINEERS
and
ASSISTANT PROJECT ENGINEERS

Vacancies exist for qualified

MECHANICAL, ELECTRO-MECHANICAL and AERONAUTICAL ENGINEERS

who will be responsible for the technical co-ordination of engineering design and development between the specialist Design Groups, within and outside the firm.

The fields covered include the mechanical and structural design of airframes, servo control systems, weapon power supply systems, ground and handling gear and all associated equipment.

Men of degree standard with experience in the general field of Engineering and the ability to analyse engineering problems are invited to apply for senior posts.

Previous experience is not essential for the more junior positions but a similar technical standard and outlook is necessary.

These positions are responsible posts and carry attractive salaries and excellent prospects.

Pleasant working conditions and amenities are provided and an attractive superannuation scheme is in operation.

All replies should be addressed to:—
TECHNICAL APPOINTMENTS OFFICER,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.,
BAGINTON, Nr. COVENTRY.
quoting Reference Pr/8/ARM/TAO. K 859

Classified Advertisements continued on Page 92

J. F. Passe & Co.

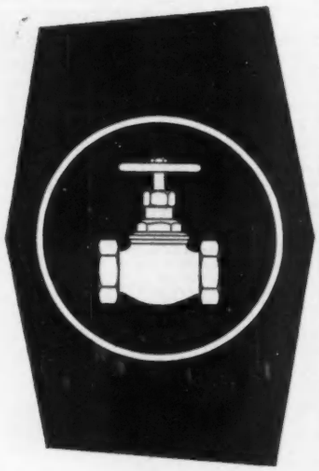
(Sole Partner: JAS. F. PASSE)

PATTERN MAKERS

PATTERNS FOR
ALL BRANCHES OF ENGINEERING
ALTERATIONS and REPAIRS TO EXISTING PATTERNS

FORBES PLACE, PAISLEY

Telephone — PAI. 2553



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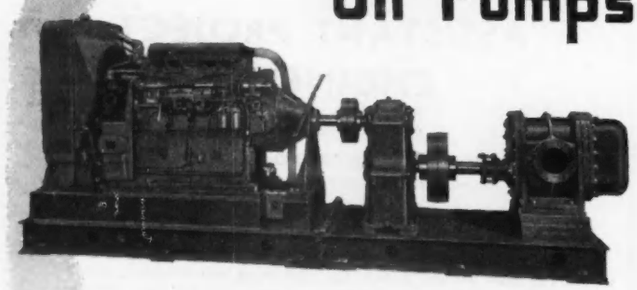
113 NEW BRIDGE ST NEWCASTLE ON TYNE

DRUM ROTARY PISTON PUMP

150/100,000 g.p.h.
Temperatures up to 600°F.

Cargo Oil Pumps



DRUM Pumps meet the requirements of the petroleum industry in a unique way, and are suitable for liquid from the most volatile to the most viscous, over a wide range of temperatures. Cargo, bunkering, transfer, road tanker, refuelling pumps etc.

THE DRUM ENGINEERING COMPANY LIMITED

HUMBOLDT STREET, BRADFORD • *Telephone: Bradford 22358*

London Office: 38, Victoria Street, Westminster, S.W.1. Telephone: ABBey 3961

Branch Offices in Glasgow, Newcastle, Manchester and Birmingham

DR 56

Are you looking for interesting and varied work connected with Design, Development, and Testing of a wide variety of new pieces of equipment for mechanical handling in Collieries and for Railway Signalling? We have vacancies for young men with ideas to work on mechanical, pneumatic and/or Electro mechanical projects.

Your are not expected to have had experience of this particular type of work, and training will be arranged where necessary for successful applicants. Some of the posts may well be filled by those with a few years' experience as a design draughtsman.

POSTS ARE AVAILABLE FOR GRADUATES OR FOR THOSE STILL STUDYING FOR THEIR NATIONAL CERTIFICATES IN MECHANICAL OR ELECTRICAL ENGINEERING and starting salaries will be in accordance with age, experience and qualifications. There is excellent scope for advancement for those with ability and initiative. Five-day week and pension scheme. For further information apply to PERSONNEL SUPERINTENDENT, WESTINGHOUSE BRAKE & SIGNAL CO. LTD., CHIPPENHAM, WILTS, quoting reference No. EQUIP/N/L. K 443

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

ARMAMENTS DIVISION.

MECHANICAL ENGINEERS

are required for work in connection with guided missiles. Previous design experience in mechanical handling or conveyor systems, together with some knowledge of rubber technology, would be useful, and it is desirable that applicants should possess H.N.C. or equivalent.

Pleasant working conditions and amenities are provided and an attractive superannuation scheme is in operation. The work is of a permanent character in a new and expanding field and salaries are good.

Replies will be treated in strict confidence, and should be addressed to :—

Technical Appointments Officer,
Sir W. G. Armstrong Whitworth Aircraft Ltd.,
Baginton, Nr. Coventry.

Please quote reference H/6/ARM/TAO. L 46

SENIOR PROJECT ENGINEERS.

LOCKHEED HYDRAULIC BRAKE CO., LTD.,
LEAMINGTON SPA

Have a number of vacancies for Senior Project Engineers. Applicants should possess an Engineering degree or be eligible for membership of a recognised engineering institution and have had about 5 years' engineering experience, preferably in the automobile field. In addition they must have drive, initiative, a flair for original design, and the ability to direct the requirements of development testing. These are Senior appointments and the commencing salary will be commensurate with experience and qualifications.—Applications in strictest confidence, should give full details of qualifications, experience and positions held, with salary, to :—

PERSONNEL OFFICER,
LOCKHEED HYDRAULIC BRAKE CO., LTD.,
TACHBROOK ROAD,
LEAMINGTON SPA,
WARWICKSHIRE.

L 28

JIG AND TOOL DESIGNERS.

Experienced Senior men required by

THE DE HAVILLAND ENGINE COMPANY LIMITED,

for work on reciprocating and jet engines.

The work is interesting, requiring a high degree of initiative, and only experienced men with good practical training will be considered.

Excellent working conditions in modern office. Five-day week. Sports and Canteen facilities.

Written applications only, to the PERSONNEL OFFICER, THE DE HAVILLAND ENGINE COMPANY LIMITED, LEAVESDEN AERODROME, NR. WATFORD, HERTS. L 11

DEPUTY CHIEF DESIGN ENGINEER.

Applications are invited for the appointment of Deputy Chief Design Engineer with a Chemical Plant and Mechanical Engineering Company.

Applicants should hold an Honours Science Degree and should have had an extensive experience of the design of Rotary and Reciprocating Compressors,

or

Chemical Plant and Equipment, including the formulation of operational plant maintenance schedules.

The appointment will entail responsibility for direction and control of a staff of qualified engineers, designers and draughtsmen.

Assistance may be given in providing housing accommodation, and removal and legal expenses will be paid.

Applications, giving full details of age, qualifications, experience and present salary to BOX K 993, Offices of ENGINEERING.

SENIOR DESIGN ENGINEERS,
with experience in the chemical engineering or associated fields and who have been concerned with design problems related to heat exchangers, fractionating columns and pressure vessels or with associated equipment, e.g., pumps, compressors.

Applicants should hold an engineering or science degree and have the ability and enthusiasm to lead a design team engaged on a variety of projects and ultimately to take up more senior executive appointments.

Applications should be addressed to THE PERSONNEL MANAGER, BRITISH OXYGEN ENGINEERING LIMITED, ANGEL ROAD, EDMONTON, LONDON, N.18. K 992

WORKS MANAGER
required by long-established and well-known YORKSHIRE COMPANY manufacturing light and medium engineering products of world-wide renown.

Only applicants now holding a similar position, having proven experience of modern machine shop practice, up-to-date production methods and foundry practice, qualified to direct shop supervision and accustomed to collaborate with organised planning and ratefixing, etc., are invited to apply in strict confidence.

Applicants should set out clearly full particulars of education, training, experience and positions held with dates and responsibilities covered.

The position advertised, arising from impending retirement, has been notified to the Company's senior personnel and is one that carries a good salary and pension.

Write BOX EG.941, c/o 191, GRESHAM HOUSE, E.C.2. K 982

JOHN LAING AND SON LIMITED

invite applications for the following technical staff vacancies :—

STRUCTURAL DESIGN ENGINEERS, preferably qualified, with sufficient design experience to undertake work on their own responsibility.

STRUCTURAL DESIGNER/DETAILERS AND DRAUGHTSMEN with good design office experience.

The appointments are mainly at Head Office, and a wide field of interesting work is covered—particularly suitable for those studying for a qualification. The posts are permanent and pensionable. Five-day week. Staff canteen. Sports Club facilities. Please apply in writing stating age, qualifications and experience to :—PERSONNEL MANAGER (S.D.2), JOHN LAING & SON, LIMITED, BUILDING AND CIVIL ENGINEERING CONTRACTORS, PAGE STREET, LONDON, N.W.7. L 73

THE BRITISH TYRE AND RUBBER GROUP

is strengthening its development organisation in order to take advantage of the increasing use of rubbers and plastics in all branches of engineering and in the general industrial field. The Group is greatly extending its experimental facilities and opportunities exist, and will continue to exist, for men with creative leadership. Applications are invited from **MECHANICAL AND CHEMICAL ENGINEERS, PHYSICISTS, CHEMISTS AND SPECIALISED TECHNOLOGISTS,** with or without experience in the plastics and rubber industries, for interesting posts in the Laboratories, Experimental Shops, Project Engineering Departments and Market Research Sections of the Group. Appropriate training will be arranged at the Group factories situated in London, Burton-on-Trent and Leyland, Lancs. Please write, giving full details of qualifications and experience, to the GROUP PERSONNEL MANAGER, BRITISH TYRE & RUBBER CO. LTD., HERGA HOUSE, VINCENT SQUARE, LONDON, S.W.1. L 59

Draughtsmen, Draughtswomen and Tracers — Mechanical Engineering.

For Engineering Consultants. Positions are permanent, pensionable, with five-day week. Free lunches. Basic Salary above A.E.S.D. minimum rates, plus profit sharing scheme.

Phone or write, giving details of previous experience, to the

PERSONNEL OFFICER, EWBANK & PARTNERS, LTD., 10/11, GROSVENOR PLACE, LONDON, S.W.1. 200 YARDS HYDE PARK CORNER. SLOANE 0486. G 630

the Busy Bee from G.E.C. says—

Production climbs when I'm around

I'm the prototype of all good 'fractionals'. Mine is the smooth, dependable power that drives precision plant . . . the moving spirit of accurate machining. I'm the polisher's inspiration, the new hope of old buffers. Life's a grind at times in engineering plant — but I'll bet a couple of thou. to an old brass washer they couldn't get along without me!

Fit G.E.C. 'Fractionals' to the machines and appliances you make or use. They cost no more, yet give you the advantages of G.E.C. dependability. Available in all standard ratings, and with a full range of mountings.

G.E.C. *fractionals*

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

ACROW

require

WORKS MANAGER

to take full control.

Special knowledge of design and production of I.C. engines, and mechanical plant as used by building and civil engineering contractors, is an advantage.

Works are in the delightful country town of Saffron Walden, Essex, and a house with an attractive garden is available.

Write, in strictest confidence, giving full details of qualifications and experience to:—

The Managing Director,
ACROW (ENGINEERS) LTD.
8 South Wharf, London, W.2

L 52

BRITISH THOMPSON-HOUSTON COMPANY, LTD.

There are vacancies in the Valve Engineering Department for work connected with the engineering and development of semi-conductor devices. Those with qualifications (H.N.C. and above) in Electrical Engineering or Physics are wanted for development projects involving transistors and rectifiers; an interest in radio would be an advantage. Qualified mechanical Engineers (H.N.C. and above) are needed to design and develop jigs and automatic machines for device manufacture.

Applicants are invited to write to the HEAD OF THE VALVE ENGINEERING DEPARTMENT (367289-1), BRITISH THOMSON-HOUSTON CO., LTD., LADYWOOD WORKS, LUTTERWORTH, NR. RUGBY, giving details of their age, qualifications and experience. K 374

The ADAMSON-ALLIANCE CO. LIMITED

have vacancies for:

★ **TWO STRUCTURAL DRAUGHTSMEN** with experience in the design of heavy steel structures.

★ **TWO MECHANICAL DRAUGHTSMEN** with experience in the design of steelworks cranes and mechanical handling equipment.

Good salary and working conditions, pension scheme, house available.

Write with full details to:
Managing Director,
The ADAMSON-ALLIANCE CO. LTD.
165 Fenchurch St., London, E.C.3.
L.30

Classified Advertisements continued on Page 94

S-B-C

Waste Heat Recovery Plant

Specialists in the design and construction of Steam-Raising Plant, utilising waste gases, in the Gas, Chemical and Ceramic Industries; also the Iron and Steel Industries. Heat-recovery from internal combustion engines and similar prime movers in Land and Marine Installations. A direct method of saving fuel.

SPENCER - BONECOURT - CLARKSON LTD

14 - 15 FETTER LANE · LONDON · E.C.4. Phone: Fleet Street 0481 and 6181

Required by

W. E. SYKES LIMITED, STAINES, MIDDLESEX

an

ASSISTANT TECHNICAL DIRECTOR

AGE 30-38

Qualifications:

(1) Wide knowledge and experience of machine-tool design in general.
(2) Some knowledge and experience of gear-cutting machines.
(3) Understanding of production methods for machine tools.
(4) University degree an advantage but not essential.

Terms of Appointment:

Commencing salary according to qualifications, but not less than £2000 per annum; pension scheme; assistance re house. An exceptional opportunity to join the higher staff of this world-wide business with subsidiaries in Canada and Australia.—Apply in confidence to Secretary of the Company as above. L 43

A SENIOR ENGINEERING EXECUTIVE preferably of 35 to 45 years of age, is required by a private company with about 800 employees engaged in the manufacture of mechanical handling plant. The position carries full responsibility to the Managing Director for an engineering department which incorporates large production drawing office, contracts and estimating office, and research and development drawing office and workshop.

An engineering degree, coupled with wide experience in mechanical engineering design and production methods and in staff leadership, organisation and control are essential. Experience of mechanical handling plant and/or of the mining industry would be an advantage. The Company is well established and has a good reputation for the quality of its products, its service to customers and its relations with employees; it is using modern management techniques on an increasing scale. A policy is being pursued of steady expansion into suitable new products and new markets at home and abroad. A person is sought to whom these factors are important, and who can take a major part in their development.

Salary will depend greatly upon the experience and qualifications of the successful applicant, but will start at not less than £2000 per annum. The position will include membership of a pension and life insurance scheme and is expected to lead to the early offer of a directorship after mutual trial period.

Applicants in the first instance are invited to send full particulars of their qualifications, experience in chronological order with dates, present position and personal particulars to URWICK, ORR & PARTNERS, LTD., 29, HERTFORD STREET, LONDON, W.1, quoting NEA/1169 on the envelope. All applications will be acknowledged and will be treated in strict confidence. K 893

SECTION LEADER DRAUGHTSMAN required to take charge of the drawing office in the newly-created SMALL MOTORS DIVISION, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH. Applicants should be familiar with the mechanical design of A.C. and D.C. machines and should preferably have some experience of small control panels. This post offers first-class opportunities for promotion and a good salary to a man able to work with the minimum of supervision. Conditions of service include non-contributory superannuation.—Please apply to the CHIEF PERSONNEL OFFICER. K 991

DESIGNER-DRAUGHTSMAN required, experienced in water-tube boilers for steam generation and/or high pressure hot water heating. Work covers the design of pressure parts, structures and casings, etc., and boiler house layouts. Good prospects with expanding company.—BOUELLAT ENGINEERING LIMITED, 167, MILLBANK, S.W.1. L 72

ENGINEER required at new Works at Loughton, Essex, to develop mechanical processes associated with handling, counting, tabulating and destroying Bank Notes in bulk.

Candidates, who must be British by birth, must have a sound engineering background with experience in design of light mechanisms and must be able to supervise development contracts. A knowledge of accounting machinery, computers or character recognition systems would be of advantage.

Starting salary up to £1100 per annum is envisaged but special consideration will be given to candidates of particularly appropriate experience. Permanent pensionable employment; financial assistance with housing available.—Apply in writing, stating full details of age, education, qualifications and experience to the STAFF MANAGER, ST. LUKE'S PRINTING WORKS (BANK OF ENGLAND), OLD STREET, LONDON, E.C.1. K 984

CIVIL AND STRUCTURAL ENGINEERING DESIGNERS, DRAUGHTSMEN AND STRUCTURAL CHECKERS required for Consultants Offices in Bristol and elsewhere in England and Wales. Must be experienced in one or more of the following: Structural Steelwork for buildings and material handling plants, Reinforced Concrete, Pipework and General Building Construction. Five-day week, optional pension scheme, good salaries and opportunities for promotion by merit.—Reply stating age, experience and qualifications to BOX K 291, Offices of ENGINEERING.

TRANSFORMER SPECIALIST ENGINEER required for a Senior Sales Post in a progressive Company. The man appointed should possess at least an H.N.C. (Electrical) and preferably be a corporate member of the I.E.E. He should have recent experience on the design of transformers up to 45 mVA, 132 kV and possess the qualities of personality necessary in a first class sales engineer. For the right man there are excellent prospects of promotion to top Management positons in an expanding organisation. Terms of employment include staff bonus and generous non-contributory superannuation.—Please apply to CHIEF PERSONNEL OFFICER, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS. K 940A

INDUSTRIAL CONTROL

(Servo Development.)

GRADUATE ENGINEER required for development work on magnetic and electronic amplifiers for servo systems in Industrial Control Applications, including Mining and Heavy Industry.

Applicants should have completed their National Service and have had experience of servo techniques and magnetic amplifiers.

The post is permanent and pensionable.

Apply for application form, quoting reference "S.4," to:—

Personnel Manager,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
Trafford Park, Manchester 17 L 44

WEAPONS RESEARCH DIVISION
A. V. ROE AND CO. LTD.
AN INSTALLATION ENGINEER

is required for design work connected with the ground and air launching of guided missiles. This is a Senior Staff position carrying a good salary and prospects of advancement in an expanding organisation.

The company has a pension and life assurance scheme, and the Division is situated in pleasant surroundings, with convenient access to Stockport and Manchester.

Applicants should possess H.N.C. or equivalent, and several years' design experience. Experience of Armament installations would be an advantage.

Applications to:

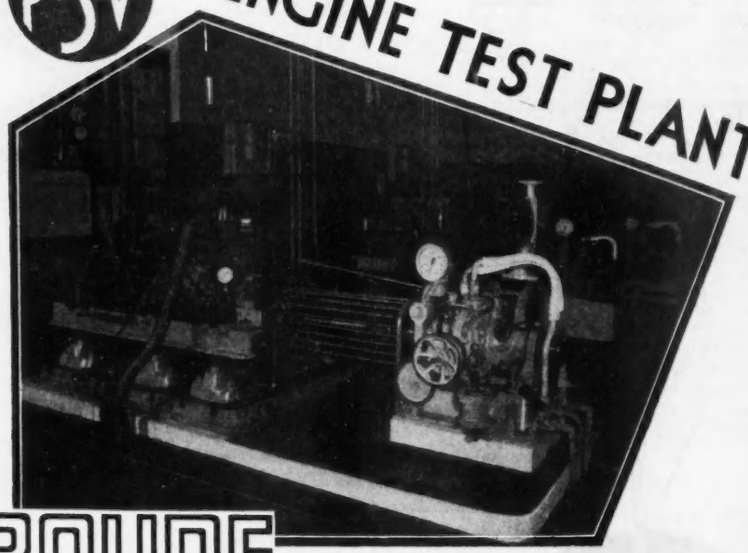
THE CHIEF ENGINEER,
WEAPONS RESEARCH DIVISION,
A. V. ROE AND CO. LTD.,
WOODFORD, CHESHIRE.

K 990

STRUCTURAL ENGINEER required by London firm of Consultants to take charge of their steel design office. Candidates must have a comprehensive knowledge of all types of structural steelwork both designing and detailing and should preferably have had some works experience. Applicants should be Corporate Members of one of the senior professional Institutions or hold similar Degrees. The post is a permanent one and there is a Staff Pension Scheme.—Please reply in confidence to BOX NO. 389, GLOVERS ADVERTISING, LTD., 351, OXFORD STREET, W.1. G 643

P·S·V

ENGINE TEST PLANT



FROUDE
Hydraulic
DYNAMOMETERS

are made in a wide range of sizes from small Dynamometers to complete Engine Test House equipment.

A lifetime's experience has brought improvements and refinements which make our products the accepted standard of B.H.P. measurement.

Illustration shows a group of Froude Dynamometers at the Tyburn Road Works of Birmingham City Transport.

The names 'Heenan' and 'Froude' are Registered Trade Marks of the Company.

H&F

HEENAN & FROUDE LIMITED
WORCESTER : ENGLAND

WILTON ICI WORKS

ENGINEERING DESIGNERS

The construction of the Company's factory at Wilton on a 2000-acre site has proceeded continuously since 1946 and now over ten million pounds are spent each year on new works. Staff with experience in design of modern works are required for this development.

The immediate vacancies are in the Design Office for :—

ASSISTANT TECHNICAL OFFICERS
MECHANICAL ELECTRICAL
CIVIL STRUCTURAL
INSTRUMENT

The appointments are to permanent staff and the Company is anxious to engage men who have had first rate experience to assist with the long-term plans for further development. Candidates in this category will be invited to interview, without commitment, at the Company's expense.

SALARIES
Commencing salaries up to £900 per annum will depend on the age and experience of candidates. The salaries of men engaged will be reviewed annually.

TERMS OF EMPLOYMENT
Five-day, 39-hour working week, Pension Fund, Profit Sharing Scheme, etc.

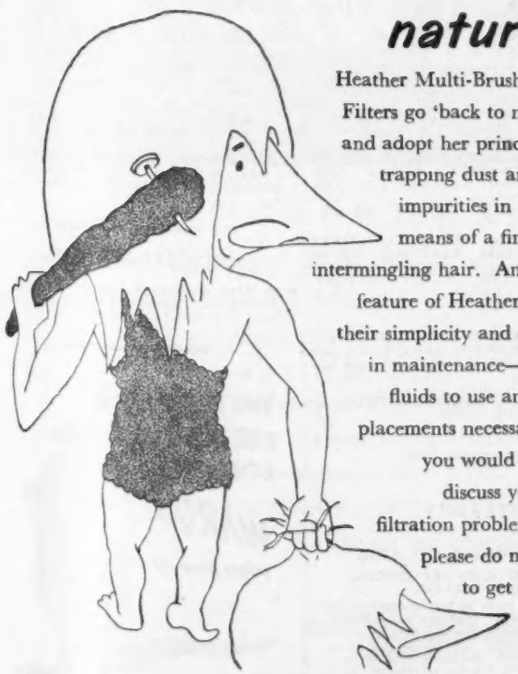
HOUSING
After joining the staff married men will receive a reasonable refund of removal (including travel) expenses, and to assist them in house purchase, facilities are available in approved cases for substantial loans; in addition, legal charges will be advanced.

Assistance is given in the procuring of rented houses, flats or lodgings.

Wilton is situated at the foot of the Cleveland Hills in Yorkshire, five miles from the coast. Working conditions are good and recreation facilities, including golf, tennis and badminton, are available.

Write for application form to: Staff Manager, Imperial Chemical Industries Limited, Wilton Works, Middlesbrough, Yorkshire, quoting advertisement reference ICI/X/293/e. L 10

RAILWAY ROLLING STOCK BUILDERS
require
A MAN HAVING EXPERIENCE IN THE PRODUCTION OF RAILWAY CARRIAGE AND/OR WAGONS and in the handling of labour matters as assistant to the Works Manager. The position holds good prospects and carries a salary commensurate with the responsibility. Birmingham Area, house available. Applications with full details of training and experience to BOX K 472, Offices of ENGINEERING.



back to nature...

Heather Multi-Brush Air Filters go 'back to nature' and adopt her principle of trapping dust and impurities in the air by means of a fine screen of intermingling hair. An important feature of Heather Filters is their simplicity and efficiency in maintenance—no messy fluids to use and no replacements necessary. If you would like to discuss your air filtration problems please do not hesitate to get in touch with us.

HEATHER FILTERS LIMITED HF

28 ST. JAMES'S PLACE, LONDON, S.W.1. HYDE PARK 7588

CIVIL ENGINEERS.

Junior Civil Engineers required for setting out and general engineering work at an Atomic Power Station Site Near Annan, in Dumfriesshire. Good Hostel available.—Apply in writing quoting reference SAR to Merz and McLellan, Carliol House, Newcastle-upon-Tyne, 1. L 29

COWANS, SHELDON & CO., LTD., CARLISLE, CRANE MANUFACTURERS AND ENGINEERS, require a
CHIEF ENGINEER, age under 40. To organise, direct and control drawing office, and be responsible for design and development of Company's products. Applicants must hold a University degree and should preferably have about 10 years' industrial experience. Post requires administrative ability and an alert progressive outlook. Salary £2000, and an endowment type pension scheme is available.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), ALMACK HOUSE, 26, KING STREET, LONDON, S.W.1, quoting C 282/6A. L 70

NEW RESEARCH LABORATORY

IMPORTANT APPOINTMENTS FOR ENGINEERS.

POWERS-SAMAS ACCOUNTING MACHINES, LTD. (one of the Vickers Group of Companies) is expanding the resources of its Research Division for the development of electronic data processing equipment, punched-card machines and allied devices. A new Research Laboratory is under construction at Caterham, Surrey—and until its completion the staff appointed will work at existing establishments in Croydon and Crayford, Kent.

Appointments, which will be at competitive salaries, and in accordance with qualifications and experience, are offered to:—

1. Engineers with graduate or equivalent qualifications for research and development work on small complex mechanisms associated with punched card accounting systems.

2. Engineers with a sound technical background and ability to analyse complex mechanisms and to effect practical and economic improvement.

Applications, with details of experience and qualifications, should be sent to THE PERSONNEL MANAGER, POWERS-SAMAS ACCOUNTING MACHINES, LTD., CROYDON. G 629

SITUATIONS WANTED.

QUALIFIED STEAM AND COMBUSTION ENGINEER, M.INST.F., A.M.I.M.E. Now holding executive post of Managerial status, desires appointment as manager or senior representative of British company in New Zealand, where he intends to settle. BOX L 53, Offices of ENGINEERING.

B.ENG., A.M.I.C.E., returning from South Africa early March. Contract planning, site organisation, tendering, shutter design, concrete control, etc. Prepared build civil contract organisation for small contractor or supervise area or similar for large contractor. £1500 or offer with prospects.—BOX L 55, Offices of ENGINEERING.

AGENCIES.

ENGINEERING AGENTS wide experience and excellent connections, are prepared to follow up quotation in the South Wales area.—BOX G 551, Offices of ENGINEERING.

WANTED.

STEEL, ALUMINIUM, BRASS, SHEETS AND OFFCUTS, 10 to 24 G. Small or Large quantities. Cash payment.—DYAS & FOWLE, 41, Loudoun Road, N.W.8. MAI. 2711, 5477. G 577

SURPLUS STAINLESS STEEL. Purchased Sheets, Strips, Bar and Tubes. Please quote sizes, finish and specification.—THE MULBERRY COMPANY, 223, St. John Street, London, E.C.1. Tel.: CLErkenwell 8356-7-8. G 455

WORK WANTED.

"DRAWINGS WITH TENDER?" Why not. Isometric Lay Out giving comprehensive illustration of exact proposals.—Apply BOX K 429, Offices of ENGINEERING.

QUALIFIED DESIGN ENGINEERS. Mechanical and Process Engineering. Projects or items of equipment designed or detailed.—Apply BOX L 48, Offices of ENGINEERING.

PRATCHITT BROTHERS, LTD., DENTON IRON WORKS, CARLISLE, having well equipped engineering shops and iron foundry, **INVITE ENQUIRIES FOR GENERAL ENGINEERING, STRUCTURAL AND PLATEWORK,** from firms wishing to have plant made to their own designs and specifications. G 511

BUSINESS OPPORTUNITIES.

U.S. CONSULTANTS.

AVAILABLE.

Experienced Engineers, Chemists, Technicians—in all fields—will undertake to solve specific problems dealing with new techniques, processes, formulae, production, cost reduction, etc. Latest U.S.A. data given. Consult us without obligation.—Write today. J. J. BERLINER & STAFF, DEPT. (LL 11), 684, BROADWAY, NEW YORK 12, N.Y. L 8

CAPACITY AVAILABLE.

FISHER FOUNDRIES, LIMITED, GREET BIRMINGHAM, for
MACHINE MOULDED PRECISION CASTINGS in gun metal and soft grey iron. G 385

ALAN MUNTZ & CO., LTD.,
RESEARCH & DEVELOPMENT ENGINEERS,
are pleased to offer experience in
DESIGN AND DETAIL DRAWING OFFICE WORK
relating to Mechanical Projects.
Also limited high-class Machining and Fitting capacity on the basis of prototype quantities.
Address:—NORTH HYDE LANE, HOUNSLOW, MIDDX.
HOU. 7081/2 and 7832. L 25

MACHINERY FOR SALE.

SOAG

LATE TYPE HEAVY DUTY LONG BED S.S. & S.C. LATHES AVAILABLE FROM STOCK.

CRAVEN 15½ IN. HEAVY DUTY S.S. & S.C. LATHE. All-geared head, with motor drive and push-button control, two saddles, each with rapid power traverse along the bed by separate motor, height of centres, 15½ in., admits between centres 14 ft. 6 in., swing over saddles 20 in., 16 spindle speeds, 1.5-145 r.p.m., approx. net weight 8 tons.

LANG 15½ IN. HEAVY DUTY S.S. & S.C. LATHE, all-geared head, single saddles, sine bar type, taper turning attach., height of centres 15½ in., dist. bet. centres 15 ft., swing over saddles 20 in., 12 forward speeds, 8.5-403 r.p.m., 4 reverse speeds, 16-338 r.p.m., h.p. of motor 20.

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Classified Advertisements continued on Page 96

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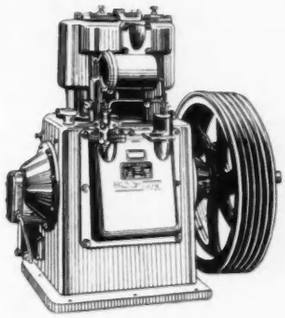

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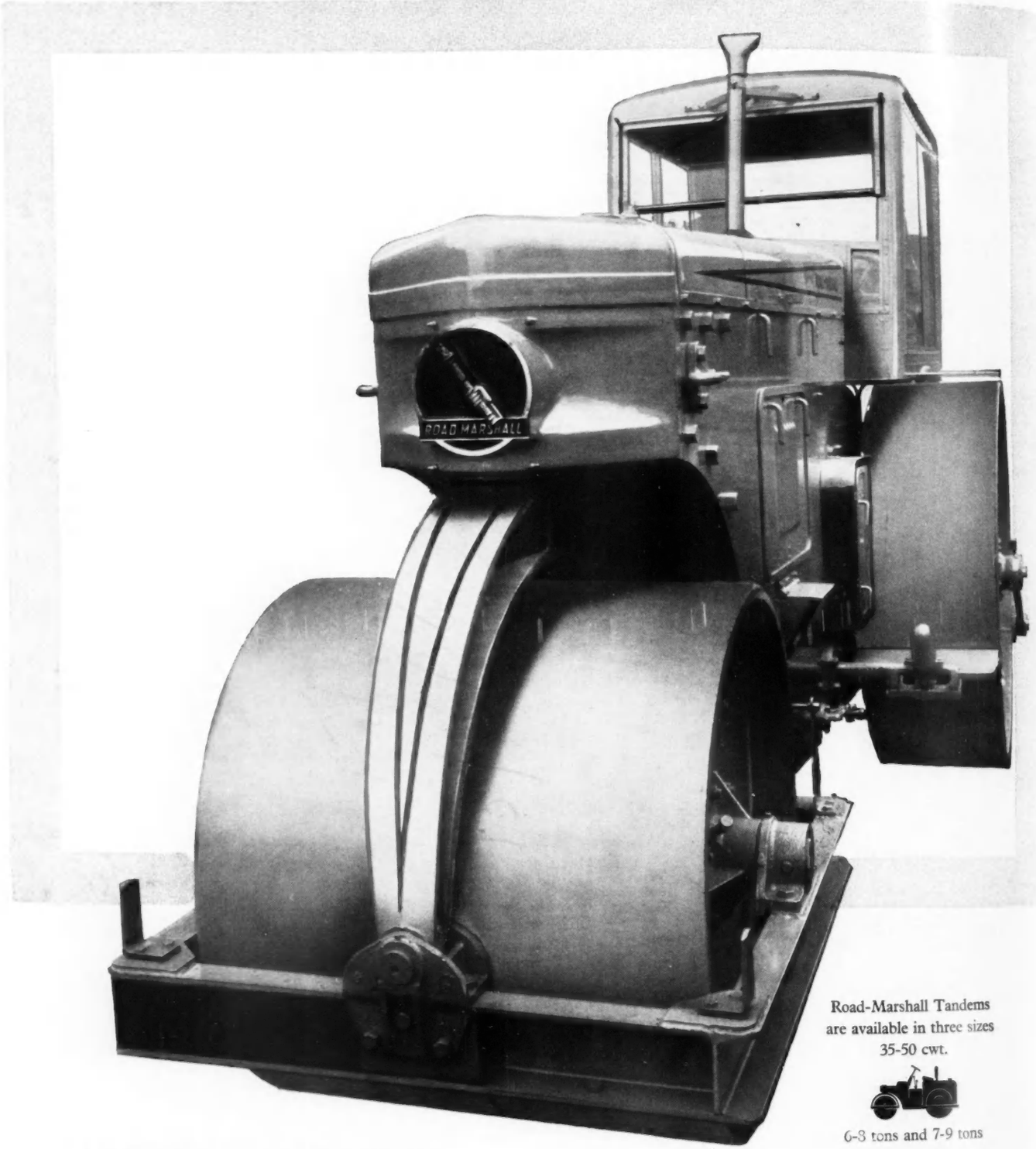

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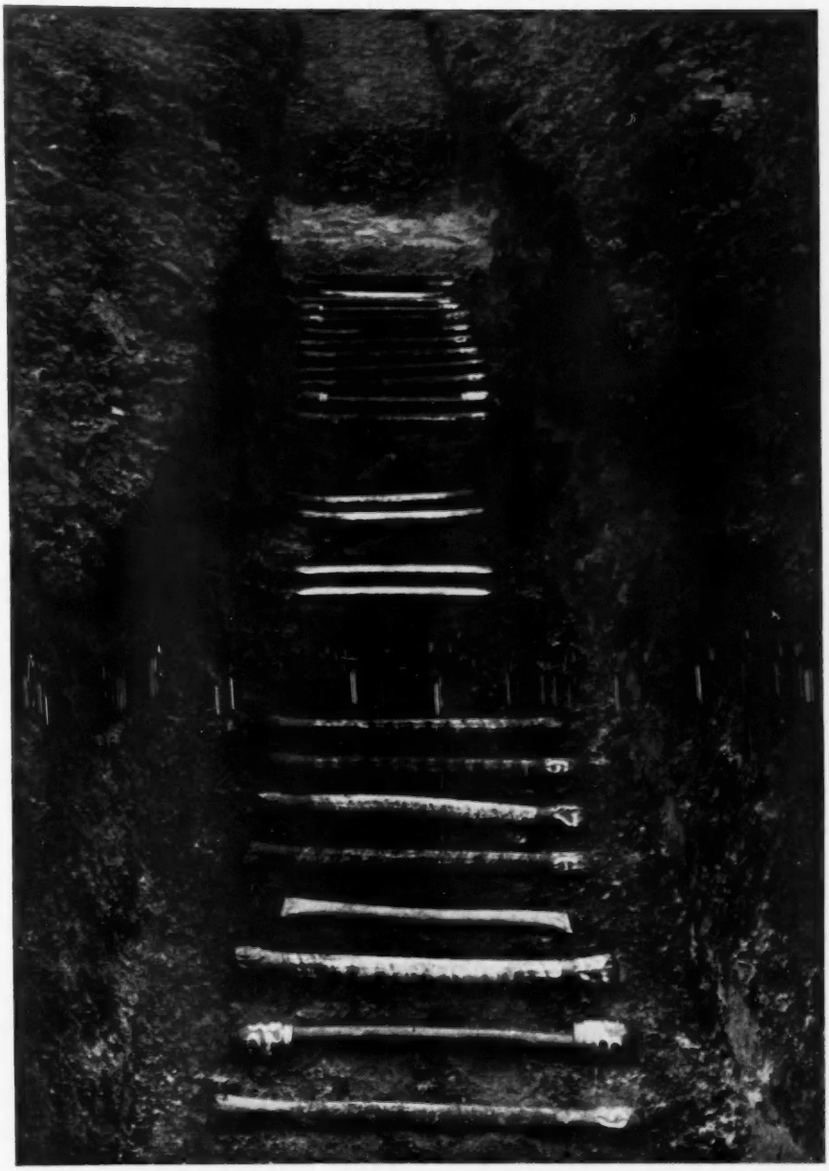

These are sample lengths of BICC Aluminium Sheathed Electric Cables. They are being buried as part of numerous experiments to find even better and more economical methods of protection against soil corrosion. The problem is complicated because corrosion is not directly related to soil chemistry. It depends upon other factors, such as the rate at which air permeates to the cable sheath and the amount of moisture present, etc.

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After making a series of small pilot tests, the BICC Corrosion Research Laboratory decided to launch a large scale research programme to study the different effects of soil corrosion on cables. Ten sites were selected to provide conditions representative of soils found throughout Great Britain. In these, a total of four thousand lengths of varying types of aluminium sheathed cable are being buried. Each site will contain ten sets of forty specimens.

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These have been specially prepared to embody all practical forms of protection, including plastics, glass fibre, asbestos, textile wrappings and chemical corrosion inhibitors. Specimens will be recovered and examined after six months, one year, two years, five years, ten years and then at further intervals to be decided from the previous results.

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CORROSION RESEARCH

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ENGINEERING
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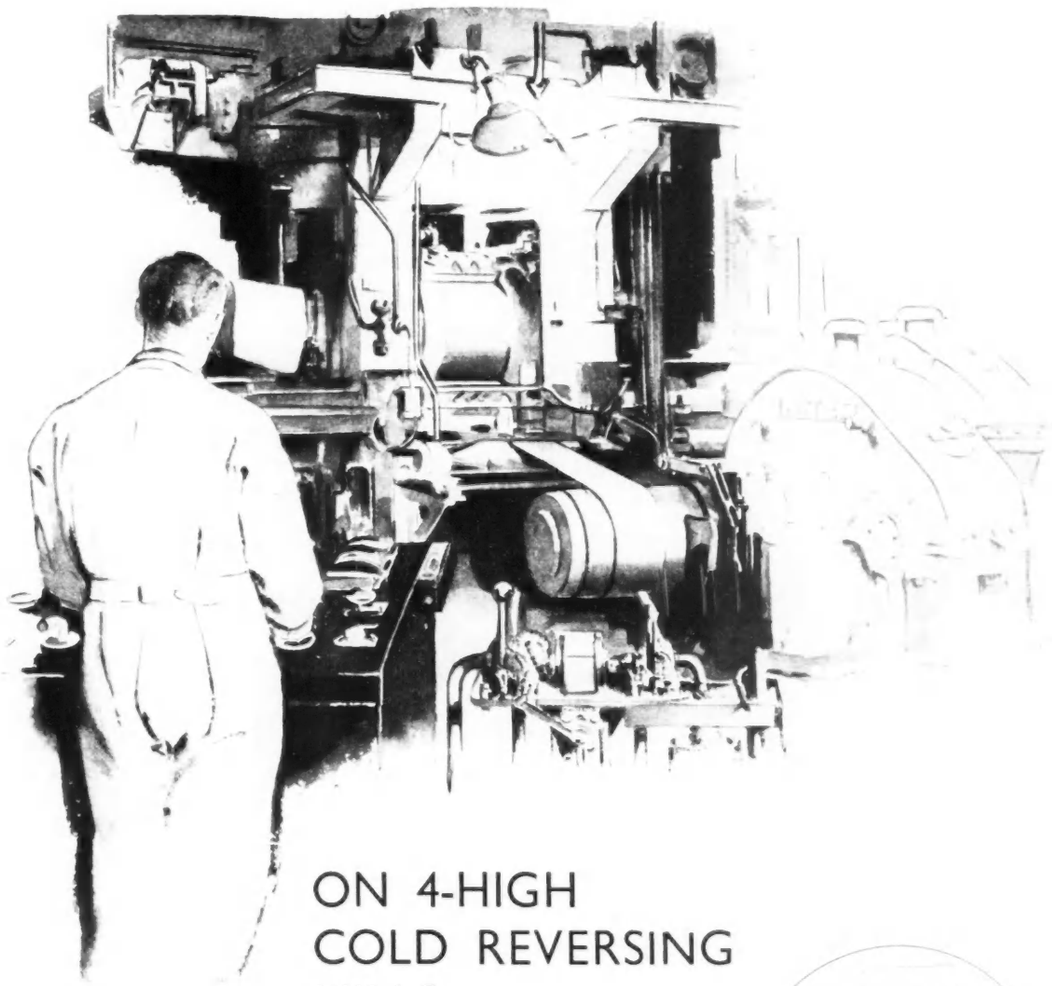

ON 4-HIGH
COLD REVERSING
MILLS

The sketch shows one of two 4-high, 10½in. and 28in. by 21in., Cold Reversing Mills at Lancashire & Corby Steel Manufacturing Company Ltd.

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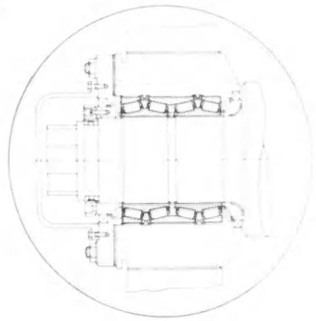

Inset, a typical installation of Timken bearings to roll necks.

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